Canada's Timber Supply: Current Status and Outlook

K.L. Runyon

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- undertakes and supports research, development, and technology transfer in forest management and utilization
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- il entreprend et appuie la recherche, la mise au point et le transfert technologique dans le domaine de la gestion et de l'utilisation des forêts
- il rassemble, analyse et diffuse de l'information sur les ressources forestières nationales et internationales et les domaines connexes
- il fait des relevés des maladies et des insectes ravageurs des forêts canadiennes
- il fournit de l'information, des analyses et des conseils (quant aux politiques) concernant l'économie, l'industrie, les marchés et le commerce reliés au secteur forestier
- il favorise les occasions d'emploi et de formation universitaire et technique dans le secteur forestier
- il encourage les Canadiens à prendre conscience de tous les aspects du secteur forestier.

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K.L. Runyon

Forestry Canada
Maritimes Region
Fredericton, New Brunswick

Prepared in cooperation with the
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Abstract

This report provides an overview of Canada's current timber supply status based on a review of recent provincial analyses. It is the first phase of Forestry Canada's National Timber Supply Study. Allowable annual cut (AAC) and recent harvest levels are presented for each province. Canada's current AAC is estimated to be 233 million m^3 — 175 million m^3 of softwood and 58 million m^3 of hardwood. Average harvest from 1986 to 1990 was 170 million m^3 of softwood and 16 million m^3 of hardwood. These harvest figures include 22 million m^3, predominantly softwood, from private lands for which an AAC has not been calculated.

The conclusions are that there is substantial hardwood supply available, but that current softwood harvest is approaching the maximum sustainable level given current biological, economic, and technological conditions. However, as shown in the study, these conditions are changing. Increased effort is being put into more intensive management including forest renewal and protection. Utilization is improving through more effective harvesting and processing, and demand for finished products is changing. These and a variety of other factors will affect the sustainable level of timber available for harvest.

In this study an attempt is made to identify these determinants and their effects, but the study is essentially descriptive and provides only a snapshot view of current conditions. The second phase of this work, which is currently underway, is aimed at understanding the dynamic nature of timber supply and demand, and providing a tool for strategic policy and program analysis.

Résumé

Ce rapport donne un aperçu de l'approvisionnement actuel en bois au Canada d'après les plus récentes analyses réalisées par les provinces. Il s'agit de la première partie de l'étude nationale de l'approvisionnement en bois entreprise par Forêts Canada. Le rapport présente la valeur des possibilités annuelles de coupe (PAC) et des dernières récoltes pour chaque province. La PAC actuelle du Canada est estimée à 233 millions de mètres cubes, soit 175 millions de mètres cubes de résineux et 58 millions de feuillus. De 1986 à 1990, la récolte moyenne a été de 170 millions de mètres cubes de résineux et de 16 millions de feuillus. Dans ces valeurs, on compte 22 millions de mètres cubes, en bois de résineux surtout, qui proviennent de terres privées pour lesquelles les PAC n'ont pas été évaluées.

On conclut que l'approvisionnement en bois de feuillus est considérable, mais qu'au rythme actuel la récolte de bois de résineux approche la limite maximale du rendement soutenu, compte tenu des conditions biologiques, économiques et technologiques actuelles. Toutefois, on constate que ces conditions changent. On s'efforce davantage d'exercer une gestion plus intensive, avec des mesures de renouvellement et de protection des forêts. Le rendement s'améliore avec l'application de modes de récolte et de transformation plus efficaces. En outre, la demande de produits finis change. Ces facteurs ainsi que bon nombre d'autres éléments influeront sur le volume de récolte qui peut être soutenu.

Dans cette étude, on tente de définir ces facteurs déterminants et leurs effets, mais il s'agit avant tout d'une analyse descriptive qui se borne à dresser un portrait des conditions actuelles. Dans la deuxième partie de l'étude, actuellement en voie de réalisation, on cherche à comprendre la dynamique de l'offre et de la demande de bois et l'on veut produire un outil d'analyse stratégique permettant d'orienter les politiques et les programmes.

Acknowledgments

This report is the result of the work of many people during the past few years. The author would like to thank the provincial government representatives who supplied much of the detailed provincial information in the appendices. Appreciation is also expressed to the Forestry Canada regional personnel for their input. Special thanks are extended to Grant Milne, Sandy Fraser, Don Haid, Diana Boylen, Joe De Franceschi, Tim Williamson, Jack Smyth, Gilles Carpentier, and Derek MacFarlane who wrote background chapters of the report. Recognition is also due to Darcie Booth, David Boulter, Jim Marshall, Mark Messmer, and Kevin Porter of Forestry Canada for their review and comments.

1. Introduction

1.1 Background

Initial concerns about timber shortages in Canada date back at least a century when availability of species such as white pine was diminishing. More than 70 years ago, concern regarding the supply of pulpwood was expressed. An article appeared in the *Canadian Forestry Journal* (Campbell, 1919) with the subtitle "Has Quebec enough pulpwood to last longer than 22 years? A vital industrial problem." Indications that pulp and paper companies were considering "... the systematic growing of at least a portion of their necessary supplies ... [was] indisputable evidence that the shortage of pulpwood supplies over considerable areas in eastern Canada is already upon us." (Leavitt, 1919).

In 1931, W.M. Robertson of the Dominion Forest Service reported that although natural reproduction was successful over much of the cut-over and burned-over lands, "It cannot be denied ... that Canada's timber situation is uncertain, perhaps serious. It is a certainty that a hiatus will occur, in some regions at least, between the time of exhaustion of the present supply and the merchantability of the new supply." (Robertson, 1931).

A few years later, the director of Forestry (Department of the Interior) reported that "Despite the immense area of forest land, unfortunately the situation with regard to timber supplies is unfavourable owing to two causes: first, the prevalence of forest fires in the past, and second, the exploitation by industry without adequate care for the future possibilities of the land. It is, in fact, estimated that the next thirty or forty years will see the end of the present merchantable timber supplies and that, subsequent to that time, timber used by industry will have to be produced by cultural methods." (Department of the Interior, Canada, 1935).

The first comprehensive assessment of Canada's timber supply and outlook, the Royal Commission on Canada's Economic Prospects, was undertaken in 1957, followed periodically by several other studies in the 1960s and 1970s. The majority of the conclusions were similar, namely that while the physical stock of resources appeared adequate to meet the then current needs, any significant expansion might be hampered by rising costs.

The last comprehensive review of Canada's timber supply (Reed & Associates, Ltd., 1978) revealed that except for New Brunswick and Nova Scotia, there were substantial physical reserves of timber but only about half of these reserves were estimated to be accessible. The report further states that "... The use of reserve figures such as these unfortunately tends to give the false impression that Canada has a comfortable timber surplus, at least for a decade or two. The fact is that many forest-based communities are in trouble today because their mills cannot secure an economic wood supply. The profile of the remaining mature forest is much less attractive than it was 10 or 15 years ago. In many areas the resource has been high-graded, and the mix of species, log sizes and grades has deteriorated measurably."

In 1979, with the initiative of the Canadian Council of Resource and Environment Ministers (CCREM), a report was prepared to highlight the growing concern for resource availability. The paper entitled "Forestry Imperatives for Canada: A Proposal for Forest Policy In Canada" stated that because of the large proportion of mature and overmature timber, land withdrawal, and losses due to fire, insects, and diseases, the current wood supply in this country could not be maintained. This was followed by a federal discussion paper on "A Forest Sector Strategy for Canada" (Environment Canada, 1981), and subsequently the report, "A Framework for Forest Renewal. Policy Statement." (Environment Canada, 1982). These papers reiterated the need for support of human resource development, research, and forest renewal, to improve our timber supply and forest industry outlook.

There have been concerns about the availability of timber for commercial use for more than a century. Yet, despite predictions of impending shortages starting as early as 1919, Canada's forest industry has continued to expand and harvests have increased. The reasons for this continued expansion are many, for example, technological innovations in processing that allowed utilization of more species and lower quality stems; improved access to previously inaccessible stands because of regional development; and reduced harvesting and transportation costs because of technological development. Continuing concerns about the long-term sustainability of our timber supply have also led to substantial increases in forest management expenditures and activities, especially tree planting.

Despite these increases in expenditures in forest management and improvements in technology, opinions on the status of and outlook for this country's timber supply remain mixed. What is our current sustainable harvest level and will it continue to increase or are we now reaching the limits of expansion? Or will we indeed have to reduce harvests in future?

1.2 The Problem

The problem is to determine the level of timber harvest that can feasibly be removed from Canada's forest on a continuing basis. This report is the first step in addressing this problem by providing an overview of our current harvest levels and harvest policies and by identifying the main factors that influence the supply of timber over time.

The identification of the characteristics and amount of the physical forest resource (that is, the current capital stock) is fairly straightforward and well documented. Forest inventories traditionally document the total quantity of timber, measured in terms of volume, and stratified by location, species, age class, etc.

We are interested, however, in that portion of the physical volume that is economically accessible. Economic accessibility is determined partly by such factors as stumpage charges, harvesting and transportation costs (which depend on tree size, logging terrain, distance from the mill), conversion costs, and product values. The extensive margin defines the limit at which it is economically feasible (that is, profitable) to extract logs from the forest.

Although there are still some problems identifying the physical dimensions of the timber resource, particularly its dynamics (that is, growth and yield and nonharvest drains from fire, insects, and disease), we can describe fairly well the state of the physical stock of timber in Canada. However, the identification of the economic attributes of the resource and the delineation of the economically accessible stock is still at an early stage of estimation. Some of the national assessments during the past 2 decades have attempted to account for the economic dimensions by identifying zones of accessibility or have combined accessibility factors with some estimate of harvestability based on size, stocking levels, and product suitability. These analyses were based predominantly on subjective information and judgment; there is simply very little quantitative information available on the economic dimensions of the timber resource. The confusion that persists about the state of this country's resources and its ability to meet future needs is primarily due to uncertainty about this economic dimension.

Furthermore, we are interested not in the absolute total volume of timber that is economically accessible, but the level of annual harvest that can be removed from this stock. Most provincial forest agencies in Canada have a policy of sustained yield, implying the removal of timber on a continuing basis at the same or increasing levels over time.

This need for consideration of the economically accessible supply of timber has been recognized as a key problem. Berndt et al. (1979) state that while there is a problem of estimating economic availability for most natural resources, "In the case of timber, the difficulty of estimating 'merchantable' reserves from extensive inventory data has plagued forest managers in Canada and elsewhere for decades." In the Report of the Royal Commission on Forest Resources (in British Columbia), Pearse (1976) says that "Most urgent is the need for a systematic method of identifying that portion of the physical inventory that can reasonably be considered harvestable in the foreseeable future." Ten years later, in a panel discussion on wood supply at the 1986 National Forestry Congress, Pearse (1986) reiterates this concern by stating that "The most important economic decision made by most forest agencies is the determination of the allowable annual cut and great efforts are taken in most provinces to determine that and, through measuring inventories and growth rates and so on, to arrive at some calculation of sustainable yields. But the credibility of those projections is weak because they often pay very little regard to the economic constraints on how much of the timber is recoverable."

The dearth of information on economic timber supply has caused confusion not only in Canada but elsewhere. This has important implications regarding how our principal trading partners view future supplies of products from Canada. In a review of the United States (and Canadian) resources in the world economy, Zivnuska (1967) referred to Dominion Bureau of Statistics figures on Canada's forest land area and percentage that was accessible. He stated:

> The significance that can be attached to the physical classification is uncertain. In an economic sense, accessibility of forest lands depends upon the value of the logs f.o.b. [free on board] mill, and the costs of extracting and delivering the logs. Thus, accessibility varies with timber values and with the development of transportation systems and must be evaluated in more than a purely physical sense. A whole gradient of accessibility classes could be visualized, with each class being characterized by some level (either positive or negative) of economic rent at a given period. Nonetheless, even the arbitrary and simple classification used in these statistics raises the question of the extent to which these forests are, in reality, a part of the current resource base of Canada.

Almost 15 years later, in an assessment of the timber situation in the United States and expectations for softwood lumber supplies from Canada, Haynes and Adams (1983) refer to Reed's (1978, 1980) studies which showed that increased timber output may not be economically feasible. From this information, it was questioned whether softwood lumber supplies to the United States would expand as anticipated in the outlook study. However, Haynes and Adams state that, "Because only limited data are available on the extent, growth, and condition of the Canadian forest resource, the likelihood of such a scenario and the attendant rates of increase in Canadian production costs are extremely difficult to gauge."

This report is the initial phase of a long-term comprehensive assessment of Canada's timber supply and demand being carried out by Forestry Canada. The problem and questions of concern are:

- What is the current supply of timber in Canada and what is the future outlook?
- What are the principal factors/determinants affecting supply?
- How have these factors affected supply historically? How might these factors change over time?
- What are some of the policy and program options for affecting supply and what are the probable impacts?
- Can we realistically model supply and demand relationships to simulate impacts of a variety of policy and program options?

1.3 Objectives

The main purpose of this report is to address the first two questions already identified: (1) What is the current timber supply situation in Canada and what is the future outlook? (2) What are the principal factors/determinants affecting this supply?

The remaining questions, particularly those related to economic availability, are being addressed in Forestry Canada's second phase of its National Timber Supply Study.

1.4 The Approach

Forest resources are largely the responsibility of the provinces and consequently most analyses are carried out at the provincial level. There have, however, been several national assessments during the past 30 years. The approach of these assessments has been to report provincial allowable annual cut (AAC) estimates as reported by these agencies. Since these estimates account in varying degrees for economic factors such as accessibility, operability, and market demand, they have been used as an approximation of economic timber supply or availability.

The basic approach of this study is similar to past studies. Each province was asked to provide information on its current timber supply status and outlook as well as methods of analysis. These AAC estimates were combined with harvest data to indicate the balance between timber availability (that is, supply) and timber harvested (that is, demand).

The report describes the state of timber supply in Canada, given the best information currently available. Section 2 provides information on the extent and physical characteristics of Canada's timber inventory — the capital stock. Section 3 is prefaced by a brief discussion on concepts and definitions of allowable annual cut and economic supply. It includes a historical review of Canada's supply situation as revealed in a comparison of AACs and harvests. This is followed by a summary of the current status and outlook for timber supply in each province, as perceived from the provincial point of view. An examination of the main issues and opportunities regarding supply is provided in section 4. These include institutional, economic, biological, and technological issues. The conclusions are presented in section 5, and published and unpublished reports in section 6. A synopsis of methods, assumptions, and results by province is included in the appendix (section 7). Section 8 is a glossary.

2. Canada's Forest Resources: A World and National Perspective

2.1 A Rich Endowment of Forest Land

Canada has a rich endowment of forest land and timber. In fact, we are among the richest countries in the world in terms of our share of land and timber relative to our population base. Our total land and water area is estimated to be about 10 million km^2 or 1 billion ha. About 93% of this is land and roughly half the land area (453 million ha) is classified as forest land.

However, only about 60% of our total forest land (244 million ha) is considered to be productive, that is, capable of producing a merchantable yield of timber in a reasonable length of time. So, even though Canada has a vast land area, only about one quarter is classified as productive for forestry purposes.

Despite this, Canada has about 8% of the world's productive forest land area (Figure 1). This is slightly more than that for the United States, about the same as that for Africa, and a little less than one third that for the USSR. Canada has about five times the combined productive forest land area of the Nordic countries. Comparison of forest land area per capita shows that we have almost 10 ha per person, while the USSR has about 3 ha per person, South America 2.5 ha, the United States about 1 ha, and Asia only about 1/10 ha.

The largest inventoried productive forest land area in Canada is located in Quebec (54.8 million ha, or 22.5% of the total), followed in order of size by British Columbia with 51.1 million ha (21%) and Ontario with 38.3 million ha (15.7%); the Prairies have a combined total productive forest land area similar to that of Quebec (56.2 million ha), and the Atlantic provinces have 21.4 million ha (Figure 2).

Of the 244 million ha of inventoried, productive forest land in Canada, about 8.9 million ha are reserved (that is, no timber harvesting is permitted), mostly in national and provincial parks. A further 25 million ha are not stocked or are of unproven stocking, and 1.6 million ha are of unclassified status. Of the remaining 208 million ha of productive, nonreserved, stocked forest land, only a portion (unknown) is economically accessible for commercial timber harvesting.

2.2 Timber Resources

2.2.1 Volume and Distribution

The geographical distribution of timber volume in the world is similar to the land area distribution. Canada has slightly more than 8% of the productive forest land area and about 7.5% of estimated total gross merchantable volume (Figure 3). As in the case of land area, Canada's timber volume is about the same as that for the United States and Africa, and slightly more than one quarter that for the USSR and South America.

Tree species in Canada vary considerably from those in other continents and countries. While Canada has only about 7.5% of the total merchantable volume of timber in the world, it has almost double that (16%) of the world's softwood resources. The majority of the world's softwood resources are in the USSR, while the major concentration of hardwood timber is in South America, which has almost 50% of the total.

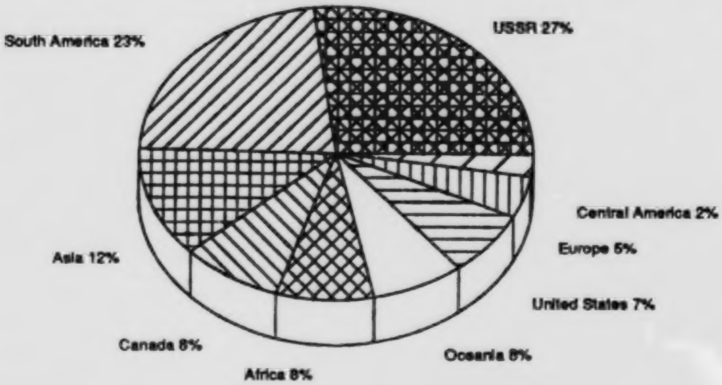


Figure 1. Distribution of the world's productive forest land area (FAO, 1985).

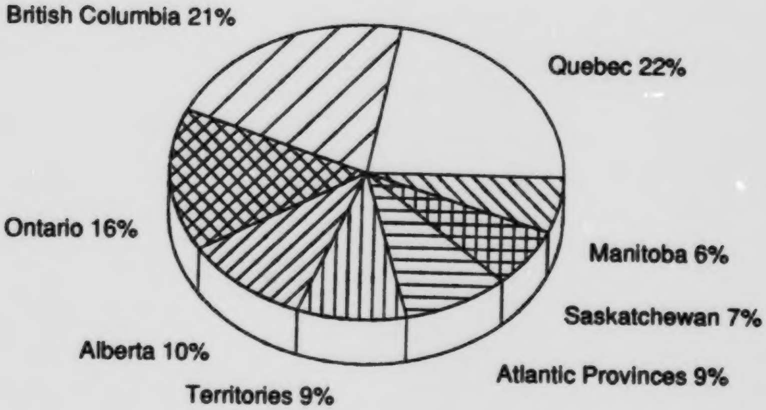


Figure 2. Distribution of inventoried productive forest land area in Canada (Forestry Canada, 1989).

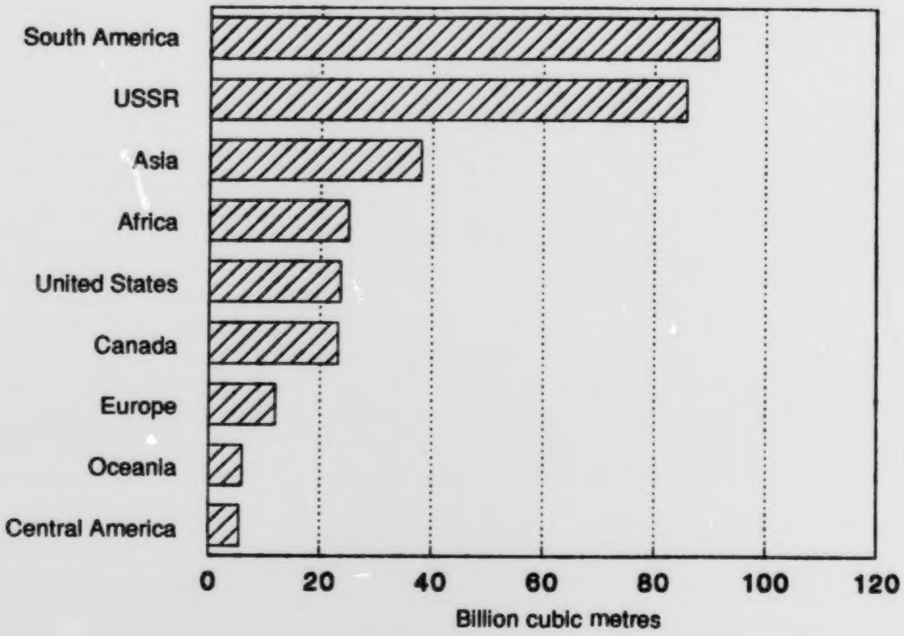


Figure 3. Distribution of gross merchantable volume of timber for selected countries and regions (FAO, 1985).

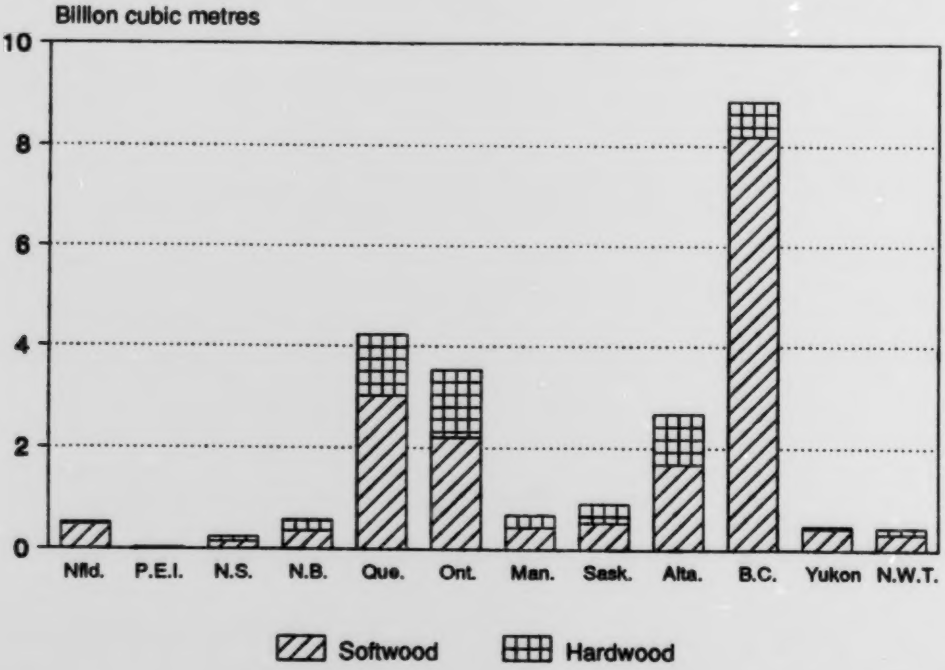


Figure 4. Distribution of gross merchantable volume of timber in Canada by province and species group (Forestry Canada, 1989).

The majority of Canada's merchantable timber volume is located in British Columbia with about 38% of the total, followed by Quebec with 18%, and Ontario with 15%. The Prairie provinces account for 18% and the Atlantic provinces contain about 6% (Figure 4).

Slightly more than three quarters of our timber volume is in softwood species, mainly spruces, pines, and firs. Our hardwood volume is made up mainly of aspen, other poplars, birch, and maple.

2.2.2 Biological Characteristics

Forest productivity in Canada is generally regarded as low due largely to the harsh climate and massive extent of the Canadian Shield which supports poorer soils. Productivity of an area relates to the potential for growth on the land base, not the forest that is actually there. The growth rate of a forest depends on its age, species, the physical factors of the site, density of trees, etc. The productivity of the land on which it grows depends on such factors as soil depth and fertility, and climate. Productivity is usually expressed as the mean annual increment (MAI) at rotation age equal to the total volume per hectare at rotation age divided by rotation age.

Information provided by the United Nations Food and Agriculture Organization (FAO, 1985) for selected countries shows that the MAI of Canadian softwood forests is about half that of the Nordic countries and other regions in Europe, about half that of the United States, and slightly more than that of the USSR. While the MAI for hardwoods in Canada is somewhat higher than for softwoods, it is only about half that of Europe and the United States (Figure 5).

Although the range of average MAIs among provinces is not large (0.5 m^3/ha per year on average for the Yukon and Northwest Territories to 2.3 m^3/ha per year average for British Columbia and Nova Scotia), the potential for growth on some sites and some species (for example, coastal British Columbia) can reach as high as 20 m^3/ha per year.

Even this rate, however, is not high compared with that reported for some of the tropical plantations in Brazil, Chile, and Argentina. Some of the eucalyptus plantations in these areas are reported to yield 70 or more m^3/ha per year. Radiata pine (an introduced species) in New Zealand is estimated to average 20 m^3/ha per year.

Even considering the harsh climate and generally low productivity of its soils, growth rates on Canada's existing forests are low. This is because a large proportion of Canada's forests are mature or overmature, meaning that their net growth (that is, growth net of mortality) may be very low or negative. Canada's national inventory data show that 6 of 10 provinces have at least 50% of their inventoried productive forest land area occupied by trees that are classified as mature or overmature (Figure 6).

2.2.3 Resource Ownership and Management

The majority of Canada's forest resources are owned by the provinces. Of the 244 million ha of inventoried productive forest land area, approximately 80% (195 million ha) is owned by the provinces; slightly more than 10% (25.7 million ha) is owned by the federal government; and the remaining 10% (22.9 million ha) is privately owned.

Forest land ownership, however, varies considerably by province (Table 1). In Prince Edward Island, for example, about 93% of the forest land is private; in Nova Scotia more than 70% is private; and in New Brunswick ownership is about equally split between public and private. In the Prairies and British Columbia less than 5% is private.

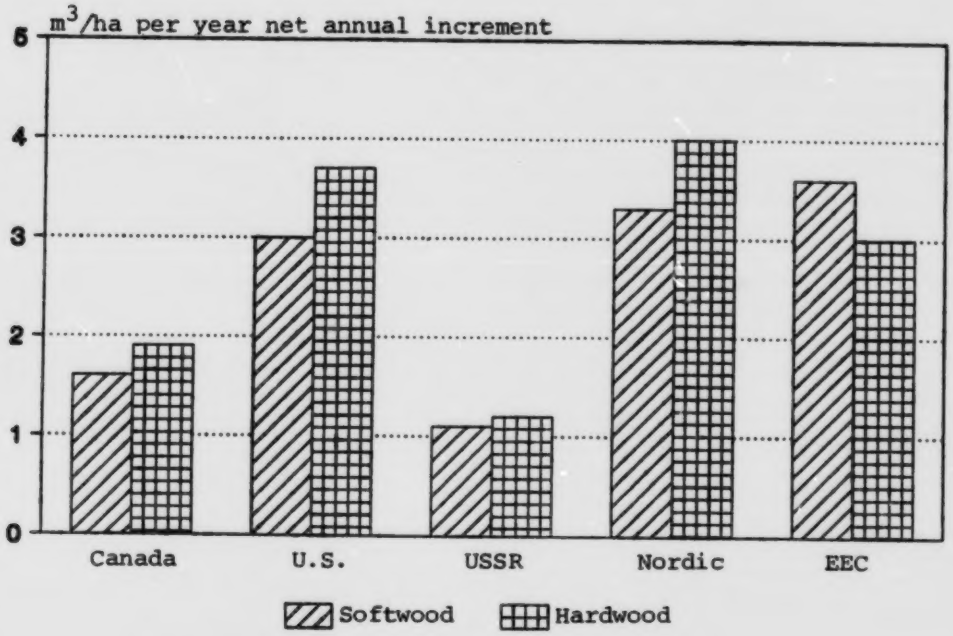


Figure 5. Comparative growth rates of forests in selected countries (FAO, 1985).

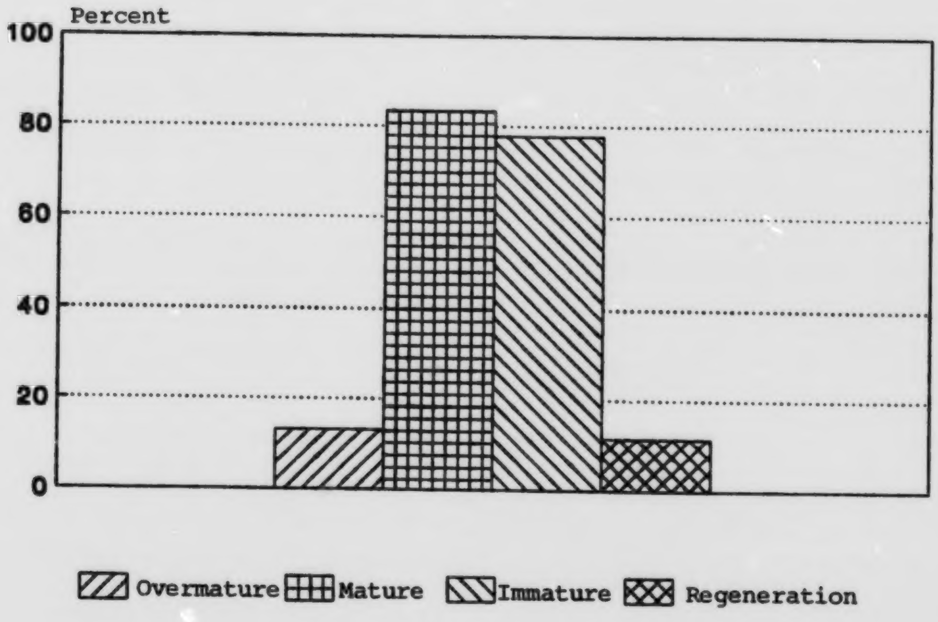


Figure 6. Maturity distribution of Canada's forests (Forestry Canada, 1989).

Table 1. Ownership of inventoried productive forest land in Canada by province.

Province	Federal Crown	Provincial Crown[a]	Private	Total
	1 000 000 ha			
British Columbia	0.47	48.65	1.98	51.10
Alberta	1.75	22.76	0.93	25.44
Saskatchewan	0.46	15.03	0.39	15.88
Manitoba	0.34	13.59	0.99	14.92
Ontario	0.25	32.39	5.66	38.30
Quebec	0.22	47.97	6.61	54.80
New Brunswick	0.15	2.96	2.98	6.09
Nova Scotia	0.11	1.02	2.71	3.84
Prince Edward Island	0.0	0.02	0.26	0.28
Newfoundland	0.06	10.71	0.40	11.17
Yukon & NWT	21.88	0.0	0.0	21.88
Canada	**25.69**	**195.10**	**22.91**	**243.70**

Totals may not add exactly due to rounding.

[a] Includes municipal and unclassified.

Source: *Canada's Forest Inventory 1986* (Forestry Canada, 1989).

Although most of the forest land in Canada is publicly owned, most of the facilities for harvesting and processing timber are privately owned. This has given rise to a variety of forest tenures, that is, agreements between the Crown and the private sectors for harvesting of timber and forest management. There are two principal types of tenures and a variety of small special agreements in use on most provincial lands. One of the principal tenures is a long-term (generally 20–25 year) agreement whereby the holder has responsibility for exclusive harvesting and significant forest management responsibility for a specified area. Timber harvested is charged at a rate that may reflect end product values, or may be based on rates determined competitively for other types of sale (for example, private lands). These agreements are generally held by large integrated forest products or pulp and paper firms.

The other principal tenure arrangement is one involving the province and a smaller company such as a sawmill and /or logging firm. These agreements generally consist of a volume allotment, are of shorter duration, and delegate less forest management responsibility to the firm. In addition to these agreements, there are a variety of permits and licenses that provide timber processors access to cut timber from provincial Crown lands. These may include a permit to cut a given volume of sawlogs or a selected species such as cedar for fence posts (Haley and Luckert, 1990).

Inventoried productive forest land owned by the federal government amounts to more than 10% (25.7 million ha) of the total for Canada. The majority of this (21.9 million ha or 85%) is located in the Yukon and Northwest Territories. The remainder of the federal lands (about 4 million ha) are distributed in national parks, Native lands, national defence areas, and experiment stations. Responsibility for management of these lands is delegated to the Territorial governments, the Department of Indian and Northern Affairs, the Canadian Parks Service of the Department of Environment, and Forestry Canada. Average timber harvest for these lands amounts to about 1% of Canada's total and the majority of this is from Native and national defence lands. There is little wood harvested in national parks.

2.2.4 Timber Production

The world production of roundwood is almost equally divided between industrial roundwood and wood used for charcoal and fuel. In 1986, Canada's roundwood production was estimated to be 177 million m^3, or about 5% of the world total. This was roughly double that for the Scandinavian countries, slightly less than that of Brazil, one half that of the USSR, and one third that of the United States.

Canada ranks third in industrial roundwood output, behind only the USSR and the United States. Canada's share of the world total industrial roundwood in 1986 was almost 11%, about twice the output of the Scandinavian countries, one third less than for Europe and the USSR, and about half that of the United States (Figure 7).

The largest proportion of Canada's timber output for 1986 was produced in British Columbia with 43.8% (77.5 million m^3 of the total) followed by Quebec with 21.5% and Ontario with 17%.

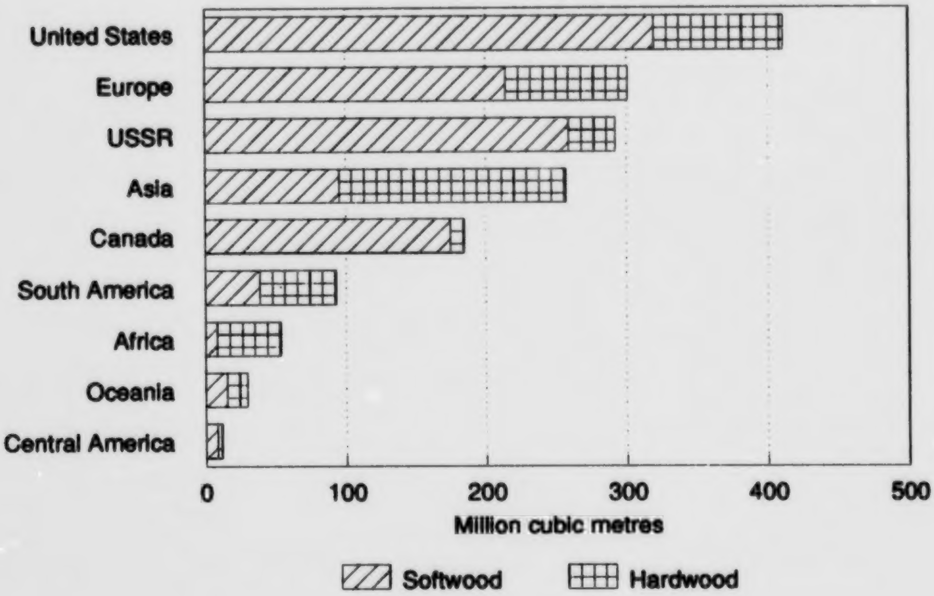
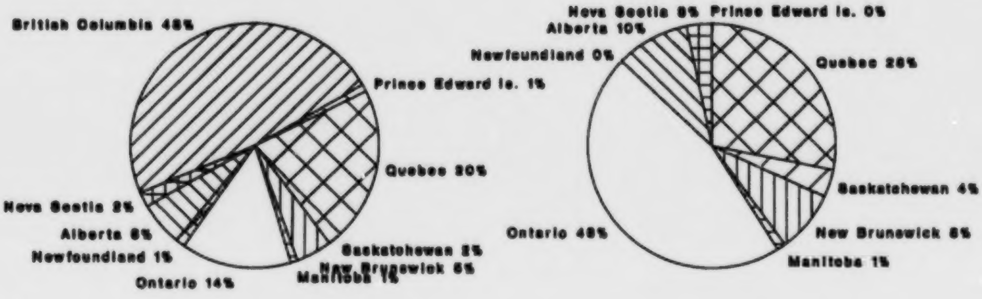
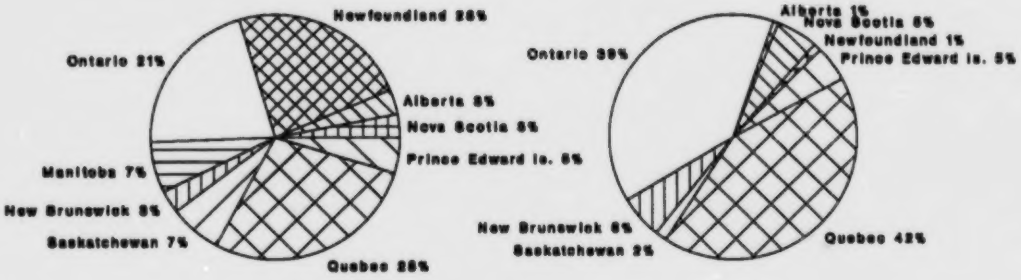


Figure 7. Industrial roundwood production for selected countries and regions, 1986 (FAO, 1989).



Industrial Softwood

Industrial Hardwood



Fuelwood Softwood

Fuelwood Hardwood

Figure 8. Roundwood production in Canada by province, 1986 (Statistics Canada Catalogue No. 25–201).

Production in the Atlantic provinces was about equal to that of the Prairies with 8.8% and 8.9%, respectively (Figure 8). Softwood species such as firs, spruces, and pines made up more than 90% of the total. Slightly more than 96% of total production was for industrial use; fuelwood utilization was estimated to amount to only about 15 million m^3 or 4% of the total.

3. Assessment of Timber Supply: Status and Outlook

3.1 What Do We Mean by Timber Supply?

Clearly Canada has a vast forest land area and volume of timber, both absolutely and relative to its population. However, what is its supply of timber? Although forests have many uses, this document focuses on the quantity of timber available on a continuing basis for commercial timber harvesting.

One way to look at timber supply is to view the existing inventory of standing timber as a stock or proven reserve similar to a mine or natural gas deposit, and then determine the rate of harvest that would deplete this reserve over time. However, because trees are a renewable resource, we can look at timber supply from a flow perspective, taking into account the growth of the forest, and determining an annual harvest that could be cut on a continuing basis.

From the first perspective, the stock is that portion of the forest inventory currently considered merchantable on the land area identified as inventoried, productive, nonreserved, and stocked (208 million ha). The mature and overmature volume on this area amounts to about 16 billion m^3. Dividing the 16 billion m^3 by our current annual harvest of about 180 million m^3, we find that the annual supply of 180 million m^3 could be maintained for 90 years. This calculation, of course, does not take into account the questions of the economic availability of that stock, or its suitability for manufacture into specific forest products. It also completely ignores the biological dynamics that occur over time in a forest (for example, growth, decay, fire).

The second, more traditional, approach incorporates these biological dynamics and recognizes the renewability of the resource. Thus timber supply is expressed as a "flow" of harvests over time, usually expressed in terms of an allowable annual cut or AAC. AAC has a variety of meanings but it generally refers to the quantity of timber that can be cut annually from a given area (forest, region, or province) without diminishing the long-term sustainability of the resource. An AAC is essentially a management tool that is used to help maintain the annual supply of timber in a region. It is based on policies that are shaped by society's values, as well as the biological and economic characteristics of the forest land base. AACs are set by the provinces and basically are a measure of how much timber forest companies are permitted to harvest annually. Based only on the portion of the 233 million ha of nonreserved productive forest that can be economically harvested, the AAC indicates the volume of wood that forest managers believe can, and should, be cut.

An AAC for a region is not a static number. The provinces recalculate AACs every 5 to 10 years, and their estimates change as factors are continually updated. Timber supply depends on biological factors (growth rates, insect/disease losses), economic factors (costs of harvesting, transportation and conversion, and product values), institutional factors (goals and constraints such as even-flow, long-run sustained yield) and technological factors (species use, recovery factors, new products, processing technology). The potential impacts of these factors will be discussed in section 4.

3.2 Harvest and Allowable Annual Cuts in Canada

The AAC is used as a proxy for timber supply, because most provincial agencies have sustainable yield as their AAC policy goal. Thus, the AAC indicates the level of annual harvest that can be removed each year on a continuing basis. Various studies over time have attempted to summarize Canada's AAC (Table 2). In 1957, Canada's AAC was estimated to be 182 million m^3. This estimate increased gradually through the 1960s and peaked in the mid- to late-1970s at about 260 million m^3. Estimates since 1980 have leveled off at about 230 million m^3 (Figure 9). The current estimate of softwood AAC amounts to about 175 million m^3 or about three quarters of the total, and hardwood AAC amounts to 58 million m^3. (This estimate of Canada's AAC includes only those lands for which AACs are calculated, and thus excludes some private lands.)

Canada's AAC estimate has likely increased over time because of technological developments, changes in species utilization, access, utilization standards, etc. The leveling off of AAC estimates in the early 1980s likely reflects the growing awareness of the differences between economic and physical timber supply. However, the estimates of Canada's AAC are based on aggregates of provincial AACs which are based on different methods and assumptions. Methods of AAC calculation have also changed over time within all provinces. These factors make it difficult to determine whether changes in Canada's AAC over time are a result of differences in methodologies and assumptions or whether they are due to biological or economic factors. Generally, however, AACs indicate our perceptions of timber availability over time. They also provide a useful comparison with trends in the amount of timber harvested over time.

During the past 30 years, roundwood production in this country has more than doubled from 86 million m^3 in 1957 to more than 190 million m^3 in 1988. Comparison of AAC with harvest shows that there has been a convergence between the two, primarily because of increased softwood harvest (Figure 10). Although data on harvest by principal species group is available only since 1970, estimated softwood AAC at that time was about 195 million m^3 while the softwood harvest volume was a little over 110 million m^3. In 1988, softwood harvest was about 174 million m^3 while estimated softwood AAC was 175 million m^3. (However, about 19 million m^3 of this harvest were from private lands for which no AAC calculation has been included.)

The hardwood picture is considerably different. AAC for hardwoods has remained virtually unchanged at about 55 million m^3 during the past 30 years. Hardwood harvest volumes during this period increased from 11 million m^3 in 1970 to only 16 million m^3 in 1988 (Figure 10).

Table 2. AAC estimates for Canada, 1957-1990.[a]

Year	Source	Softwood AAC	Hardwood AAC	Total
			1 000 000 m^3	
1957	Davis, 1957 (Gordon Commission)	127	55	182
1960	Wilson, 1966	155	57	211
1968	Manning and Grinnell, 1971	-	-	240
1971	Reed and Associates, 1974	196	33	229
1976	Aird and Ottens, 1979	177	40	217
1977	Bowen, 1978	205	72	276
1978	Reed and Associates, 1978	205	51	256
1979	Environment Canada, 1981	174	54	228
1980	Reed and Associates, 1980	205	-	-
1983	Nilsson, 1983	167	40	207
1986	Canadian Forest Industries Council, 1986	166	59	225
1988	Woodbridge, Reed and Associates, 1988	175	59	233
1989	Reed, 1989	166	-	-
1990	Runyon, 1991	175	58	233

[a] Figures represent the estimated AAC for "economically accessible" lands.

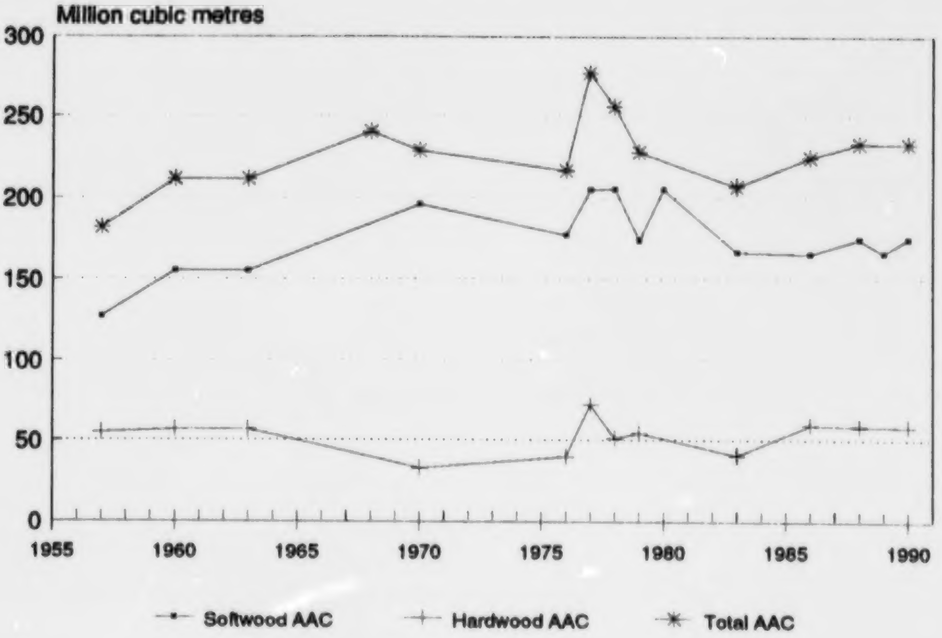


Figure 9. Estimates of Canada's allowable annual cut (AAC), 1957–1989 (see Table 2).

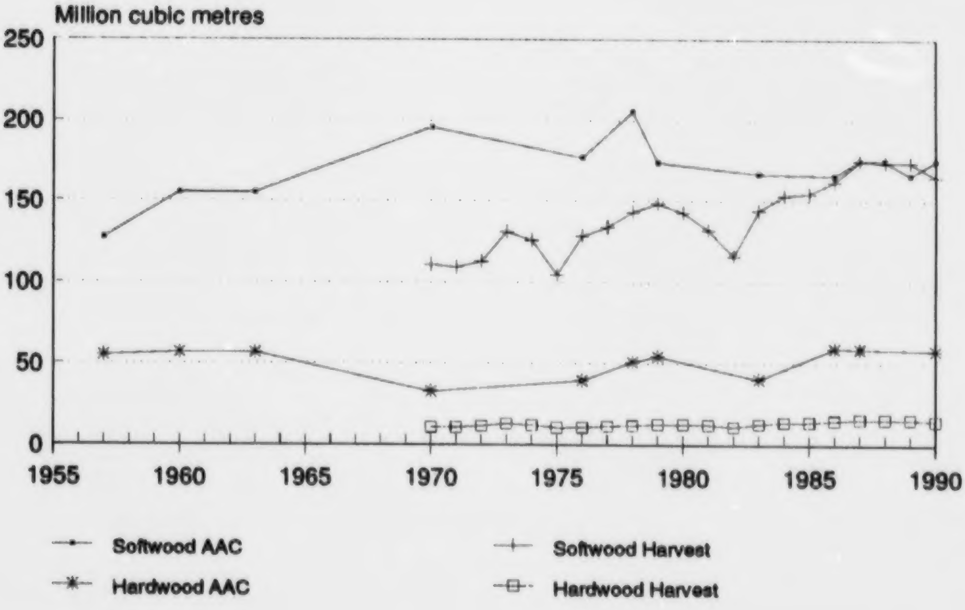


Figure 10. AACs and harvests in Canada. (Harvests are from Statistics Canada Catalogue No. 25–201. 1987–1990 harvests are estimated. AACs are from various sources.)

3.3 Current Status of Timber Supply

To provide an updated assessment of timber supply in Canada, Forestry Canada surveyed each of the provincial agencies. An attempt was made to determine not only the provincial AAC estimates for both softwoods and hardwoods, but also to identify the methods of analysis and principal assumptions. This survey was conducted mainly in 1989 and although an attempt was made to update figures where possible, some figures may already be obsolete because of revised analyses since then. Although only a summary of the findings is provided below, a more detailed synopsis for each province is provided in the appendix.

3.3.1 Methods and Principal Assumptions

Historically, AACs were estimated using relatively simple formulae. Increased use of computers and better data have resulted in techniques permitting the simulation of forest development and harvesting for long periods. Computer models help decision-makers determine sustainable levels of timber supply, given various assumptions about growth, removals due to fire, insects, and diseases, and harvest levels. While these techniques have permitted greater flexibility in predicting and assessing biological development and characteristics of the forests (volume, diameter, height, quality), only modest improvements have been made in accounting for economic dimensions (costs of logging, transportation and processing, and value of the log).

The approach to AAC calculation in most provinces is to first net down the forest land base to delete areas that are environmentally sensitive, too steep or too expensive to log, reserved for wildlife management, inaccessible, etc. On the remaining area, inventory volume and characteristics are projected over time, given assumptions about growth and yield (taking into account endemic levels of insect, fire, and disease losses and silvicultural inputs), harvest scheduling, and utilization. Several scenarios may be examined or simulated based on target levels of industrial requirements, silvicultural inputs, assumptions regarding minimum stocking levels, land tenure, etc. Inventory projections are generally run for at least one rotation which may be from 80 to 200 years.

This simulation process combined with provincial or industrial policy goals and constraints provides the basis for selection of an AAC. In most provinces, the AAC is set for 5 years, after which time it is reevaluated. The AAC is not necessarily the long-run sustained yield (LRSY) level, although sustainability is usually a long-term objective. The AAC may be higher than LRSY if there is a high proportion of mature and overmature stock, and the management agency decides to minimize natural mortality and loss, through a more rapid depletion. It may also be lower than LRSY, depending on the age structure of the forest and management objectives. The AAC may be for an administrative region, a license, or a forest management area, depending on the management agency. The provincial AAC is the sum of AACs for every individual unit, and summing the provincial AACs produces the national AAC.

Because of differences in methods, constraints, and assumptions, it is difficult to assess and compare timber supply problems and opportunities among various jurisdictions. Areas that are considered inaccessible in some provinces are netted out of the forest land base, while in others they are not. Furthermore, the figures presented below are at the province-wide level. The problem with this level of aggregation is that there may be a surplus (AAC greater than harvest) for the province as a whole but a deficit for a particular mill or region.

Some provinces calculate AACs for private as well as Crown lands. The AACs for private lands are estimates of sustainable production on these unregulated lands, but they are not in any way enforceable. The private landowner may or may not choose to place timber on the market. In some provinces, there is no estimate available for private land AACs.

3.3.2 Provincial Timber Supply

Approximately one third of the total AAC (75 million m^3) is in British Columbia. AAC estimates for Quebec and Ontario are 55 million m^3 (24%) and 45 million m^3 (19%), respectively. The Prairie provinces have a combined AAC of about 38 million m^3 or 16% of the total for Canada and the remaining 21 million m^3 (9%) is in the Atlantic region. The largest proportion of the softwood AAC is located in British Columbia (43%), while the hardwood AAC is mainly centered in Ontario, Quebec, and Alberta (Table 3).

Analysis of historical trends in harvest levels and AAC shows that there has been a convergence between the two during the past 15 years. Current softwood timber supply as represented by the AAC estimates approximates current commercial requirements (Table 4). In 1986, the estimated softwood harvest was almost 162 million m^3 or about 13 million m^3 less than the AAC. About 19 million m^3 of this harvest came from private and unregulated lands in British Columbia, Ontario, and Alberta, for which no AAC is calculated by provincial agencies. From 1986 to 1990, total estimated softwood roundwood production averaged 170 million m^3. Again, some of this harvest came from private lands, so the apparent surplus is greater than the 5 million m^3 indicated. When compared at the province-wide level, all provinces show a small apparent surplus of softwoods for 1986, the last year available for provincial level statistics.

To consider the implications for Canada of a harvest level that is approaching or is equal to the AAC, we must answer three questions. First, are the AACs presented sustainable at the current level? If they are, then the current level of industry can be maintained. Second, what factors could cause the AACs or sustainable harvest levels to decrease? Third, what strategies can be adopted to increase the AACs, and allow further industry expansion?

Table 3. Estimated current AAC in Canada by province and species group.

	Allowable Annual Cut (AAC)		
Province	Softwoods	Hardwoods	Total
	1 000 000 m^3		
British Columbia	74.7	–[a]	74.7
Alberta	15.1	11.6	26.7
Saskatchewan[b]	3.6	3.0	6.6
Manitoba	2.6	2.3	4.9
Ontario[b]	28.4	16.9	45.3
Quebec	35.7	19.0	54.7
New Brunswick	8.1	3.6	11.7
Nova Scotia	3.5	1.8	5.3
Prince Edward Island	0.3	0.2	0.6
Newfoundland[c]	3.0	–	3.0
Canada	175.0	58.4	233.4[d]

Totals may not add exactly due to rounding.

[a] A separate AAC for hardwoods is not calculated.

[b] AAC is maximum allowable depletion from all sources.

[c] Figure includes Labrador. A separate AAC for hardwoods is not calculated.

[d] Some private lands are not included in this number. The harvest on these lands in 1986 was about 22 million m^3.

Sources: Forestry Canada and provincial government estimates.

Table 4. Comparison of softwood AACs and harvests.

Province		AAC	Average Harvest (1982–86)	1986 Harvest
		1 000 000 m³		
B.C.[a]	Crown	74.7	62.2	68.0
	Private	–	9.1	9.5
	Total	74.7	71.3	77.5
Alberta	Crown	15.1	–	7.4
	Private	–	–	2.0
	Total	15.1	7.6	9.4
Saskatchewan	Crown	3.6[b]	–	–
	Private	–	–	–
	Total	3.6	2.5	3.1
Manitoba	Crown	2.6	1.3	1.6
	Private	0.0	0.0	0.0
	Total	2.6	1.3	1.6
Ontario	Crown	28.4[b]	15.0	15.8
	Private	–	5.4	7.7
	Total	28.4	20.4	23.5
Quebec	Crown	31.0	–	–
	Private	4.7	–	–
	Total	35.7	30.3	33.1
New Brunswick	Crown	4.4	–	–
	Private	3.7	–	–
	Total	8.1	6.6	7.6
Nova Scotia	Crown	0.9	–	–
	Private	2.6	–	–
	Total	3.5	3.0	3.3
P.E.I.	Crown	0.1	–	–
	Private	0.2	–	–
	Total	0.3	0.2	0.2
Newfoundland[c]	Crown	3.0	–	–
	Private	–	–	–
	Total	3.0	2.5	2.4
Canada	Crown	163.8	–	–
	Private	11.2	–	–
	TOTAL	**175.0**	**145.7**	**161.9**[d]

Dash indicates not available.

[a] Includes hardwoods. "Crown" includes some private lands in TFLs. "Private" includes some unregulated Crown.
[b] Maximum allowable depletion from all sources.
[c] Includes Labrador. "Crown" includes some private.
[d] Approximately 19.2 million m³ of this harvest is from private and unregulated lands in British Columbia, Alberta, and Ontario for which no AAC has been calculated.

Sources: Forestry Canada and provincial annual reports.

These questions are not easy to answer. The first question will be addressed in this section, and the following two in section 4.

Atlantic Region — The Atlantic provinces include New Brunswick, Nova Scotia, Newfoundland, and Prince Edward Island. Because of the high percentage of private lands in this region, provincial agencies also assess the potential of private lands. The Crown-owned productive forest land base is netted down for low volume and stands on steep slopes. Assumptions regarding the availability of private woodlots differ by province. In New Brunswick, for example, 100% of private woodlots are considered to be available for supplying timber, while in Nova Scotia only 60% of private woodlots are assumed to be available for harvesting.

The aggregate AAC for the Atlantic region is about 20.5 million m^3. About 70% of this (14.9 million m^3) is softwood, and the balance is hardwood, although almost 90% of current harvests are softwood.

Table 4 indicates that there is little apparent surplus of softwood in the Atlantic region. Commercial harvest for the region in 1986 was 13.5 million m^3, while the unused portion of the AAC was only 1.4 million m^3 or 10% of the total. (Five-year average harvest was 12.3 million m^3.) Given the continuation of current silvicultural investments and protection efforts, the AACs for New Brunswick, Nova Scotia, and Prince Edward Island are likely sustainable in the long run, with some increases in AACs expected over time for both Nova Scotia and Prince Edward Island. However, Newfoundland will likely face shortages during the next 2–3 decades, as its current industrial needs exceed its AAC. The AAC will likely decline even with intensive silviculture. New Brunswick may also require increased levels of silvicultural investment simply to maintain its current harvest during the next 30–40 years.

The potential for expansion in these provinces depends largely on the level of silvicultural investment carried out. In addition, the AAC includes 6.5 million m^3 of softwood and 3.2 million m^3 of hardwood from private woodlots in New Brunswick, Nova Scotia, and Prince Edward Island. Because these are unregulated, there is a certain amount of uncertainty associated with this portion of the timber supply.

There is considerable unutilized hardwood AACs in both New Brunswick and Nova Scotia (Table 5). Current harvests are only about one third of the potential in these two provinces. An AAC for hardwoods in Newfoundland has not been calculated, although current harvests have averaged less than 50 000 m^3/year.

Quebec and Ontario — The provinces of Quebec and Ontario are typical of most Canadian regions, with more than half of the productive and available forest land in mature and overmature classes. Only about 12% of forest land is in private nonindustrial woodlots.

Average harvests from 1982 to 86 for the two provinces were about 61 million m^3. Total 1986 harvest was 68.8 million m^3, with about 83% of that from softwoods. The AAC for the region is not easily estimable. As shown in Table 4, the AAC given for Ontario is really a Maximum Allowable Depletion (MAD), that includes depletions from fires and insects as well as harvest. Analysts' estimates of the AAC vary from 34.0 to 45.5 million m^3, depending on the assumptions made. Woodbridge, Reed and Associates (1988) used an estimate of 43.9 million m^3 (27.0 million m^3 for softwoods and 16.9 million m^3 for hardwoods), which leads to an AAC estimate of 98.6 million m^3 for the region of which about two thirds is softwood. There was an additional 11 million m^3 harvested on private lands in Ontario in 1986, which, if sustainable, increases the AAC estimate to 104 million m^3.

Table 5. Comparison of hardwood AACs and harvests.

Province		AAC	Average Harvest (1982–86)	1986 Harvest
			1 000 000 m^3	
B.C.[a]	Crown	–	–	–
	Private	–	–	–
	Total	–	–	–
Alberta	Crown	11.6	0.6	0.8
	Private	–	–	0.2
	Total	11.6	–	1.0
Saskatchewan	Crown	3.0[b]	0.3	0.5
	Private	0.0(est.)	–	0.0
	Total	3.0(est.)	–	0.5
Manitoba	Crown	1.8	0.1	0.1
	Private	0.5	0.0	0.0
	Total	2.3	0.1	0.1
Ontario	Crown	16.9[b]	3.4	3.8
	Private	–	2.3	2.8
	Total	16.9	5.7	6.6
Quebec	Crown	11.2	–	–
	Private	7.8	–	–
	Total	19.0	4.8	5.0
New Brunswick	Crown	1.6	–	–
	Private	2.0	–	–
	Total	3.6	1.1	1.1
Nova Scotia	Crown	0.8	–	–
	Private	1.0	–	–
	Total	1.8	0.5	0.6
P.E.I.	Crown	0.0	–	–
	Private	0.2	–	–
	Total	0.2	0.2	0.2
Newfoundland	Crown	–	–	–
	Private	–	–	–
	Total	–	0.1	0.1
Canada	Crown	46.9	–	–
	Private	11.5	–	–
	TOTAL	**58.4**	**13.5**	**15.2**[c]

Dash indicates not available.

[a] AAC for hardwoods is included with softwoods for British Columbia.
[b] Maximum allowable depletion from all sources.
[c] Approximately 3.0 million m^3 of this harvest is from private and unregulated lands for which no AAC has been calculated.

Sources: Forestry Canada and provincial annual reports.

Figures for Quebec indicate that there is a small unutilized reserve of softwoods. Quebec has experienced substantial losses to the spruce budworm, and also has a high percentage of mature and overmature forests that are declining in volume. There is a substantial portion of the inventory that has not been included in the AAC calculation because of accessibility. Increased prices would bring substantial supply into the economic margin.

The opportunities for expansion of softwood utilization in Ontario appear to be greater than in Quebec. However, since Ontario's forest is heavily skewed to older age classes, the future timber availability is forecast to decline during the next 40 years. This is a function of acceleration of harvests permitted under the MAD calculation. However, since the harvests have not been fully accelerated, the outlook is not very clear. Furthermore, it is unclear whether the total MAD numbers have been netted down for economic accessibility.

Both provinces have significant unutilized hardwood AACs. The harvest in 1986 was 11.6 million m^3, compared with an AAC of about 36 million m^3. (A further 2.8 million m^3 was harvested from private lands in Ontario.)

Prairie Provinces — The Prairie provinces encompass Alberta, Manitoba, and Saskatchewan. While Alberta has more than 50% of its productive forest land in mature and overmature age classes, Manitoba and Saskatchewan have only 18–20% of their productive forest land in these older age classes as a result of the frequency of wildfires. All three provinces net down the productive forest land base to eliminate low volume stands and stands that are in areas of high elevation or steep slopes. Some economic accessibility is considered in the netdown, primarily for the most northern areas.

The total AAC for the Prairies is about 39 million m^3, softwood accounting for about 55% of that. (Similar to Ontario, the AAC for Saskatchewan is actually a Maximum Allowable Depletion. Once provisions are made for wildfires and other depletions, the harvestable AAC would be less. For example, in 1985, the total depletions excluding harvest were about 1.2 million m^3 for softwood and about the same for hardwoods. If these were representative, then this would reduce the AAC for the Prairies as a whole to about 36.2 million m^3.) The harvest in 1986 was 14.1 million m^3 of softwoods and 1.6 million m^3 of hardwoods.

Possibilities for expansion appear to be greatest in Alberta. The apparent unutilized softwood reserve in Alberta is almost 6 million m^3, but there has been considerable industrial development since 1986, so the majority of this apparent reserve is now allocated or committed. The softwood surplus in Saskatchewan disappears when other depletions are accounted for. Manitoba has 1.0 million m^3 of softwood surplus. There is also a substantial unutilized hardwood AAC in all provinces, but particularly Alberta. Additional timber supply could become available under improved economic conditions, because a substantial portion of Manitoba's and Saskatchewan's inventory is currently inaccessible and not included in the AAC figures given.

British Columbia — Fully 63% of British Columbia's productive forest land base is in mature and overmature age classes. The forest land base is netted down for economic and environmental reasons, so that only about 50% of the available forest land is considered in the AAC calculations. British Columbia's current AAC on regulated lands is about 75 million m^3 of predominantly softwoods. Current harvest is about 68 million m^3 and has averaged about 62 million m^3 from 1982 to 1986. There is also an additional 9–10 million m^3 of harvest on unregulated private lands. The apparent unutilized surplus in British Columbia appears to be substantial in absolute terms, but it represents only about 5% of the 1986 harvest and this is not evenly distributed geographically. Furthermore, the AAC reported in Table 4 for British Columbia is projected to decline over time as the old growth inventory becomes depleted. However, there is some opportunity for expansion under improved economic conditions, because a large portion of the inventory is netted down for economic accessibility reasons.

There are several caveats that must be identified with interpretation of the numbers presented in Tables 4 and 5. The AAC estimates are based on a variety of assumptions such as the growth rate of trees; losses due to fire, insects, and disease accessibility; economic conditions; environmental constraints; level of silvicultural investment; level of protection; and a host of other policy/management objectives. Many of these factors are subject to considerable uncertainty and are difficult to predict, yet specific assumptions must be made to calculate the AAC. If conditions differ from those used in the AAC estimates, the accuracy of the AAC will suffer accordingly. Furthermore, the "AACs" for private lands are only very rough estimates of the timber supply level that will be offered for sale, and are not controllable, which confounds the estimation of a realistic AAC for Canada. About 10% of the estimated AAC for Canada is based on private lands in Quebec and the Atlantic provinces. A further 19 million m^3 of softwoods and about 3 million m^3 of hardwoods are harvested from private and unregulated lands in British Columbia, Ontario, and Alberta, for which no AAC is calculated by the provincial agencies. This is an important consideration when comparing "total harvest" figures with AAC figures.

The AAC estimates generally apply to a 5-year period. Most provinces allow the annual amount of harvest within this period to vary (in some cases plus or minus 50%) to permit industry flexibility to adjust for market cycles. In addition, some variation (plus or minus 10%) may be allowed for the 5-year period. Therefore, a year-to-year comparison of harvest and AAC can only be a rough guide to how fully we are utilizing the sustained yield of the forest.

In addition, the AAC numbers presented are for the province as a whole. Although there may be an apparent surplus for the entire province, there may be serious regional or specific mill shortages. The quality of roundwood available may also be limiting in that smaller logs may preclude utilization as sawtimber.

A further caveat is noteworthy regarding harvest levels. For most provinces, total harvest figures given in Tables 4 and 5 are based on Statistics Canada estimates of total roundwood production. Because of interprovincial transfers of logs, these numbers may be subject to some error.

Remembering these caveats, some general conclusions can still be drawn. The supply of softwood timber is being almost fully utilized, that is, the annual harvest is approaching the AAC. Under current economic conditions (for example, costs of production and market prices), there is only limited opportunity for expansion. However, there is considerable physical supply that would become accessible under improved economic conditions and there appears to be considerable opportunity for increased use of hardwoods.

3.4 Outlook for the Future

In the medium term (20–30 years), Canada's timber supply will come from the trees that are currently established. A large proportion of these are biologically mature or overmature and thus are ready for harvest now. If not harvested, they will become more susceptible to catastrophic losses to fire, insects, and disease and will lose volume. The quantity of these trees that can be harvested on an annual basis and the length of time during which this harvest can be sustained depend on how effective we are at scheduling the harvest; protecting against fire, insects, and disease; utilizing a variety of species; and accessing remote stands. The majority of the softwood surplus is in Ontario, but this is misleading because the numbers in Table 4 must be netted down for other depletions as well as accessibility. In addition, the surplus in Alberta is mostly committed.

The hardwood AAC for the country is about 58 million m^3, but average harvests from 1986 to 1990 were only 16 million m^3, leaving an estimated reserve of 42 million m^3. The majority of this reserve is located in Alberta, Ontario, and Quebec, although much of Alberta's hardwood reserve has since been allocated.

Information on timber supply outlook provided by the provinces indicates that the current levels of softwood harvest can be sustained for the medium term (20–30 years) assuming that current management practises and market conditions remain unchanged from current levels. There is also considerable potential for expansion of hardwood harvests.

As well, in many provinces, there are large areas of timber that are too remote now. These areas pose real opportunities for the medium and long term. The physical extent of the forest land base far exceeds the area of forest that is economically accessible. As economic conditions improve, for example, product prices increase or technological advances reduce logging costs in remote areas, more forest area can be included in the land base for AAC calculations, and thus the sustainable levels of harvest will increase.

The outlook for timber output in the longer term (beyond 30 years) appears to be somewhat more optimistic in terms of opportunities for expanding levels of sustainable harvests, partly because we have more flexibility in our approaches. There is potential change as a result of basic silvicultural practises such as tree planting. There is the expectation of substantial gains in quantity as well as quality from genetic improvement. Technological improvements in harvesting and processing will enable areas to be logged that were previously inoperable because of steep terrain, and a wider range of tree species will be useable. Reductions in losses through improved protection are also possible.

Factors that are expected to have negative impacts in the long term are changing land use, that is, removal of land from timber production, and increasing constraints on protection measures, particularly measures involving the use of chemicals for control of insects or vegetative competition.

Generally, existing provincial analyses indicate the opportunity for an increased timber supply in the long term, that is, beyond 30 years. This view, however, is very much conditional on maintaining or expanding the current level of effort in forest regeneration, in improved protection, technological advances in utilization, etc., and on maintaining the currently allocated forest land base for timber production.

The sustainable level of Canada's timber supply depends heavily on several biological, economic, institutional, and technological factors. The provincial estimates of AACs are all based on several assumptions regarding these factors. What impact do these factors have? What opportunities do we have for modifying these factors to increase our timber supplies? The answers to these questions are complex and not immediately answerable at this stage. However, the identification of the important influences on timber supply in Canada is an important first step in addressing the strategic questions of how to increase our timber supply in the future.

4. Forest Resource Issues: Problems and Opportunities

The summary of provincial timber supply analyses presented in section 3 leads to the conclusion that Canada's softwood timber supply appears to be sustainable at its current harvest level, but that there is little potential for expansion.

What determines the level of sustainable timber supply? Honer and Bickerstaff (1985) suggest the following:

1) available area of productive forest land
2) volume, age, and condition of the timber now growing on the land
3) growth capability of the land and the timber
4) intensity of forest management
5) annual harvest levels
6) rates of depletion by fires, pests, and natural disasters, and
7) constraints on the economic availability of productive areas and volumes.

In addition, management goals and society's preferences as well as technological developments will have significant effects.

Some of these factors are within our control, albeit at a cost: if we want to increase our level of sustainable timber supply, what strategies can we adopt? In this section, we examine in further detail some of the institutional, biological, economic, and technological factors that influence estimates of timber supply.

4.1 Institutional Issues

There are several issues affecting timber supply that result from our institutional arrangements, that is, our laws, customs, principles, and practises. The present institutions have been influenced largely by the early land settlement pattern in Canada and the constitutional allocation of powers over resources. As indicated earlier, about 80% of the inventoried productive forest land is owned by the provincial governments, while the remainder is approximately equally split between the federal government and the private sector. The distribution of forest land among the three ownership groups differs substantially by province. In the Maritimes, almost 60% of the forest land is privately owned, while in British Columbia and the Prairies, this proportion is only 3–4%. This distribution of land ownership affects the impacts of institutional factors on timber supply in each province.

4.1.1 Tenure Systems

As noted earlier, harvesting on provincial Crown lands is done almost exclusively by private companies under license agreement with individual provinces. These arrangements grant companies the rights to cut timber; they provide no rights to water, wildlife, or recreation resources The granting of large tracts of Crown land and timber through lease, license, or permit in return for the assurance of investment in and operation of processing facilities has been the cornerstone of much of our regional development in Canada. The terms of these early agreements are considered by some to have been too generous: resource rents paid for use of the public resource were not determined by competitive bid and were considered to be too low; responsibility for renewal was not required of the licensee or was not rigorously enforced where there was a requirement. However, provincial governments viewed the timber resources as having a low opportunity cost; there were essentially no alternative uses, and the granting of forest land tenures provided, at the time, an inexpensive method for regional development.

Current Crown land tenures vary somewhat across the country but generally involve two principal types with several small special agreements. One of the principal types is a long-term (20–25 year) agreement whereby the holder has responsibility for harvesting and forest management for a specified area. The charges often include a rate per cubic metre cut with a fixed rate for land holding and possibly protection. Costs of renewal, road building, and protection may or may not be borne by the licensee. The second principal type of agreement involves a volume allotment. It is often of shorter duration than the area agreement and may not require the holder to be responsible for forest management. In addition to these two types of tenure, there are a variety of permits, leases, and letters of authority. These agreements are generally for shorter periods, for given quantities, possibly only certain species, and often do not require the holder to be responsible for management.

The type of tenure therefore directly affects the degree of incentive for investment by industry, and the responsibility for management. The type of costs, level of prices charged, and security of the tenure affect the willingness to invest and degree of uncertainty faced by the industry.

4.1.2 Sustained Yield Policies

Sustained yield is a principle that has long been entrenched in the resource management policies of most provinces. While the specific interpretation of the principle varies somewhat, the underlying premise is the continuous and where possible increasing flow of long-term timber supply. The policy of sustained yield is usually based primarily on biological criteria — maintenance of the quantity of output over time without consideration of economic and technological criteria. Thus available supply is constrained to a level that is below what might be optimal given prevailing or forecasted market conditions. However, short-term demand fluctuations are accounted for in some instances by allowing harvest levels to vary substantially from the AAC on an annual basis so long as the variation for a 5-year term is small

One factor that significantly affects the supply of timber in Canada is our high proportion of mature forest. A normal or regulated forest should be made up of equal areas of forests of each age class. Then an equal area of forest is harvested in each year from the oldest age class, which is at the harvest age. This forest provides an even flow of timber over time, and the harvest is equal to the volume grown that year.

However, a large percentage of Canada's forests are biologically old, with more than 52% of our productive forest land area classified as mature or overmature stands. This age-class structure results from the small amount of logging relative to the total productive forest area, in combination with the suppression of wildfires that would normally have occurred in some areas. Thus most of Canada's forests have simply continued to age. (Note that while 52% of our productive forest land base is mature or overmature, only a percentage of our productive forest land base is currently commercially operable. The age-class distribution on this commercially operable portion of the land base likely has a lower percentage of mature and overmature stands, since this is the portion that has been harvested during the last century.)

This age-class distribution has several implications for timber supply. It presents an opportunity in that these trees are ready for cutting now; we do not have to wait until they reach a harvestable size. This provides us with considerable flexibility in the sequence and level of harvest. Assuming that this volume remained unchanged until harvested, and it was all accessible, we could theoretically cut at the current rate for 90 years before the mature and overmature stock was exhausted.

However, this is not a realistic scenario because forest stands change over time. As trees age they succumb to natural mortality; they become more susceptible to insects and diseases, fire and wind damage; and they often become more brittle, resulting in higher breakage during harvesting operations.

The large percentage of mature and overmature forests in Canada complicates the application of a sustained yield policy in Canadian regions. A high percentage of old growth provides several management options. Generally, a "conversion period" is specified, over which time all of the old growth will be harvested, and at the end of this period, the forest will have an approximately equal area in each age class. The harvests during this conversion period will often be larger than those sustainable in the long run. In British Columbia, for example, the volumes harvested on old growth areas far exceed those expected to be harvested once second growth reaches harvestable age. In other provinces, current harvests may be greater because larger areas are harvested than would normally be the case under the LRSY, to prevent volume losses from decay and insects as trees age beyond their biological age of maximum growth. The interim period, between the conversion of the old growth and the harvest of the LRSY, provides a certain flexibility. Expected growth rates of second growth also affect the LRSY and hence the current harvest levels. However, in the next 30-60 years, our existing stock of timber will be the most significant factor affecting wood supply. The rate at which we cut it now will affect the levels at which we can cut it later.

4.1.3 Private Land Management

Although the principle of sustained yield is the basis for policies on most Crown lands, this is not the case on private lands. In some provinces, there is an attempt to calculate an "AAC" for private lands. However, since neither the management nor use of private land is controlled by the province, the AAC figure is only a guideline for planning purposes, and provides an estimate of how much timber will likely be supplied to the market by private owners.

As shown earlier, private lands account for about 10% of the total productive forest land in Canada. In 1986, estimated roundwood production from these lands was almost 18% of the total. In the Maritimes region, private land production accounts for two thirds of the total harvest. In British Columbia, the average harvest from private and unregulated lands during the past 6-8 years has been about 10 million m^3 or more than 10% of the total harvest.

Timber supply from private lands is not easily predictable. Private landowners, particularly nonindustrial owners (who own 6% of inventoried productive land), do not necessarily manage their lands with the objective of supplying commercial timber on a sustained yield basis.

4.1.4 Environmental Regulations

Legislation to safeguard against environmental damage has a material impact on timber supply. There are regulations that prohibit harvest of lands (or restrict harvesting methods) along streams or watersheds and highways. Regulations that restrict harvest methods and locations can significantly affect timber costs and therefore supply. A preliminary estimate of the amount of productive forest land in Canada that is not available for commercial timber harvesting because of policy constraints in Canada is about 15% — an area similar in size to the inventoried productive forested area of Ontario. This refers to such constraints as reserve buffers on streams and lakes, restrictions on harvesting in areas of shallow soils, provision of wildlife habitat and forest surrounding fish spawning bed sites. A further 9 million ha are reserved in parks and ecological reserves where harvesting is prohibited by law.

In addition, there are a variety of regulatory measures that restrict management practises including the use of chemicals for protection against insects, disease, and fire, as well as control of unwanted tree and shrub competition.

4.2 Forest Depletions

The supply of timber is also affected by forest depletions. The main sources of depletions are harvests, fires, insects, and disease.

Harvesting, insect and disease attacks, and fires can temporarily remove area from the productive state. Insects and disease tend to reduce the volume and quality of stands, while harvests and fires usually result in total loss of volume. Insect and disease damaged areas may need to be salvage harvested or burned so that they can be made productive again. For any of these depletions, the length of time an area remains unstocked will negatively affect the amount of timber grown in a given year and therefore the available timber supply.

From 1977 to 1981, it is estimated that fire, harvesting, and pests affected about 2.2 million ha annually or slightly more than 1% of the productive, stocked, nonreserved forest area at that time. Fire accounted for 43% of this area, followed by 34% for harvesting, and 23% for pests (Honer and Bickerstaff, 1985).

More recent data on the area harvested and fire-damaged annually is shown in Table 6. During the 10 years from 1979 to 1988, annual area harvested has increased from 876.4 thousand ha to 1021 6 thousand ha, an annual compound increase of about 1.5%. Productive forest land area burned for a similar period (1980–1989) averaged slightly more than 780 thousand ha/year.

Table 6. Productive forest land area harvested and burned, 1979–1988.

Year	Area harvested[a]	Area burned
	1000 ha	
1979	876	–[b]
1980	881.4	1354.7
1981	802.6	1305.8
1982	762.9	833.6
1983	830.0	409.7
1984	898.1	181.0
1985	901.6	132.8
1986	1018	311.4
1987	1012.9	312.9
1988	1021 6	639.7
1989	–	2338.2

[a] Data are for fiscal years (for example, 1975 = 1975/76).

[b] Data not available.

Sources: Kuhnke, 1989; Forestry Canada, 1990; Ramsey and Higgins, 1982 and 1986

The comparable volume losses are not easy to determine. While there are up-to-date estimates of annual volume of timber harvested, it is difficult to get annual information for volume losses due to fire, insects, and disease. Data for 1977 to 1981 show that of a total estimated average annual volume depletion of 290 million m^3 from the productive nonreserved forest land base, approximately 50% of this was from commercial harvest, 28% resulted from fire, and the remainder was due to insects and disease (Honer and Bickerstaff, 1985). On a regional basis, the majority of insect losses occur in Eastern Canada while the fire losses are most prominent in the West.

Spruce budworm appears to be the most damaging pest in Canada and possibly North America. Data compiled by Forestry Canada in 1981 show that the estimated average annual mortality and growth loss due to spruce budworm was about 45 million m^3, about one third of the volume harvested in 1981 and one quarter of the current harvest. Outbreaks of spruce budworm are known or suspected to have occurred regularly for many centuries. Other important pests are a variety of beetles, and diseases including decays, cankers, and mistletoes. Estimated annual losses from these agents is about 62 million m^3.

4.3 Forest Protection

Although a certain amount of loss to insects, disease, and fires is unavoidable, one way of increasing the amount of timber harvestable over time is to reduce these losses through increased protection efforts. Significant natural depletion allowances are usually made by provincial agencies when calculating AACs. Reducing these losses would permit increases in annual harvest levels. Obviously, these protection measures are expensive, and there is a trade-off between the benefits to be gained by increasing amounts of protection and the expected losses without the increase in protection. However, the relationship between expenditures and reductions in losses is difficult to determine.

Various technological advances have made improvements in detection and protection efforts against insects such as the spruce budworm: improvements such as better survey methods for detection, replacement of chemical controls with biological control agents, and productivity gains in the application of the insecticides. There has been a gradual decline in the area treated for insect pests, but it is difficult to determine whether this is a result of more effective detection and suppression or whether it is due to natural biological causes.

Data on area of pest control in Canada from 1975/76 to 1985/86 show that there has been a decline in area treated from approximately 5.5 million ha to about 1.5 million ha. This decline is primarily due to a reduction in area treated for spruce budworm in Quebec and New Brunswick. In 1985, the total area of forests in Canada estimated to be moderately or severely damaged by spruce budworm was 20 million ha (Kondo and Taylor, 1986). The area sprayed by insecticides was 1.5 million ha, of which about half was chemically treated and about half was treated with biological control agents.

The main methods for reducing losses from insects and disease are chemical and biological control through aerial spraying. Although the area treated is already declining, there is continued pressure to reduce spray programs even more, for environmental and health reasons. Use of biological control agents for insect protection is increasing and research to find nonchemical alternatives is continuing. However, current nonchemical methods are often more costly, and may not be as effective as chemicals. Unfortunately, there are few alternatives, other than trying to plant more insect and disease resistant trees for the long term. Continued research into pest control alternatives could yield significant benefits for reductions in volume losses.

Analysis of historical data on forest area burned in Canada shows that there was a gradual but steady decline in area burned from about 1920 to the late 1960s, followed by a sharp rise in the 1970s, a peak in 1980, followed by a further decline and another peak in 1989. (Productive forest land area burned as a percentage of total forest land area burned varies from about 15% to 50% in a given year, but averages about 30%. Sixty percent of forest land is classified as productive, thus clearly most fires occur in the nonproductive forest land base.)

While there has been improved effectiveness in detection and suppression, fire losses still make up a significant proportion of the total annual depletion, and the random nature of their occurrence makes them difficult to predict.

4.4 Land Use Changes

Forest land may be permanently removed from the productive forest land base for such uses as parks, wildlife refuges, power transmission lines, dammed lakes for hydroelectric power, urban development, and roads. There are also accruals to the forest land base, for example, from the reestablishment of forest cover on abandoned agricultural land. The balance appears to be a net loss in forest land, although there is little definitive information on these land use changes.

One alternative to losses to alternative land uses is multiple or integrated land use. The issue of integrated forest management is a relatively new concern in Canada compared with Europe and the United States. In theory, a range of production possibilities exists in natural and managed stands. At one end of the spectrum is full multiple use management with a wide array of outputs each of similar importance, while at the other end is single use management with output of one product such as timber of primary interest.

In many western European countries, multiple use policies have developed in response to diverse demands on a limited forest resource by a large population. Canada has favored single use management for timber (forest management licenses, leases, permits), for recreation (national and provincial parks), and wildlife or ecological reserves. Presently, about 50% of Canada's forest land is classified as unreserved and productive forest land and is available for commercial timber production. However, as population, leisure time, and demands for nontimber outputs increase, there will be pressure to change from this single use to multiple use.

The impact of these pressures on timber supply is difficult to determine. It will depend on the quantity and quality of resources involved, their location, the type of uses and restrictions, etc.

4.5 Silvicultural Investment

During the past 15 years, we have increasingly changed our mode of operation from one of mining to one of forest management. From 1975 to 1988, the area of land planted or directly seeded annually has more than tripled from 162 thousand ha to 451 thousand ha. This represents a doubling in the percentage of area harvested that is artificially regenerated (that is, seeded or planted) (Table 7). Substantial areas are also successfully left to regenerate naturally, however. Postharvest conditions may resemble those after natural disturbances, and for some species, natural regeneration is the most effective method of reestablishing forest cover.

Table 7. Area harvested compared with area regenerated in Canada.

		Artificial Regeneration							
		Gross Areas[a]							
Year	Total Area Harvested[a]	Planted	Seeded	Total	Estimated Successful Artificial Regeneration[b]	Estimated Successful Natural Regeneration[c]	Total Successful Regeneration (Artificial & Natural)	**Area Successfully Regenerated as % of Total Area Harvested**	Estimated Area Not Adequately Regenerating[d]
	1000 ha								1000 ha
1975	682.6	128.0	34.3	162.3	110.1	341.3	451.4	**66.1%**	231.2
1977	735.1	121.7	42.7	164.4	110.6	367.6	478.2	**65.0%**	257.0
1979	876.4	143.0	39.4	182.4	123.6	438.2	561.8	**64.1%**	314.6
1981	802.6	169.6	42.6	212.2	144.1	401.3	545.4	**68.0%**	257.2
1983	830.0	215.7	37.3	253.0	173.3	415.0	588.3	**70.9%**	241.7
1985	901.5	261.0	26.2	287.2	198.5	450.8	649.3	**72.0%**	252.3
1988	**1021.6**	**413.3**	**37.7**	**451.0**	**312.0**	**510.8**	**822.8**	**80.5%**	**198.8**
Average 14-Year Period 1975–1988	835.7	207.5	37.2	244.7	167.5	417.9	585.3	**70.0%**	250.4

[a] Kuhnke, 1989; Forestry Canada, 1990.

[b] Based on estimated success rates of 70.1% planting and 59.2% seeding (Kuhnke, 1989).

[c] Based on assumed successful natural regeneration of 50% of harvest area (Kuhnke, 1989).

[d] Areas not adequately regenerated do not necessarily remain so forever. These areas can become restocked through natural regeneration over time. Presently, there is insufficient data on the length of time required for this to occur. This period is often referred to as the "regeneration lag."

Generally, the sooner forests are regenerated after harvest (or destruction from other causes), and the faster they grow once established, the greater will be the wood supply. The converse will also be true. However, these new forests will only affect the wood supply in 30-60 years.

In the 10 years from 1977 to 1988, approximately 10.6 million ha were harvested. Of this, 25.5% was planted, 4.5% was directly seeded, and the remaining 70% was left to regenerate naturally. Not all of this harvested area has since become or remains "satisfactorily stocked." Factors such as competing vegetation and severe weather conditions have resulted in some seedling mortality or poor growth.

In most provinces regeneration success is judged by the type and the quantity of trees that become established within a reasonable time period. Nonsatisfactory regeneration of an area is generally reflected in lower stocking levels rather than complete failure. Virtually all of the forest land in this country will regenerate itself naturally given enough time. However, in addition to the long period required, the types of trees that do come back may not be the most desirable given our processing facilities and our markets.

For some species and sites, we can accelerate the regeneration process and significantly expand the yield of useable volume through planting. If left to nature, many sites that are logged or burned will grow back but may take 10-20 years to become reestablished. By planting sites after disturbance, we can reduce this period by half or more.

Preliminary information indicates that about half of the forest areas that are left to regenerate naturally are considered to be successful. (Note that the different provinces use different lengths of time after harvest to estimate regeneration success; the time period is usually between 5 and 10 years.) Planting success rates (that is, percentage of total planted area expected to become satisfactorily stocked without retreatment) are about 70-90%, while direct seeding success rates are about 60% (Kuhnke, 1989). Thus overall success rate for regeneration has increased from about 66% in 1975 to more than 80% in 1988 (Table 7).

The area of productive forest land in Canada that is roughly estimated to be nonsatisfactorily restocked (NSR) is about 16.2 million ha or about 7% of the total productive forest area (Honer and Bickerstaff, 1990). Note that the areas that are classified as NSR at any one time do not necessarily stay in the NSR classification. Through both natural regeneration and planting, some areas will become stocked, while at the same time other areas may become NSR. Significant efforts have been made in recent years to plant the backlog NSR in most provinces. However, it is difficult to estimate whether the area of NSR is declining over time, because of lag times for survey updates.

Earlier it was shown that although Canada has a rich endowment of forest land and timber, the productivity of the forests is quite low compared with most other countries. Average productivity in Canada is only about half that of the United States and the Scandinavian countries, and even less than half that of many tropical countries. Increases in potential growth rates can be achieved through more intensive forest management. Planting genetically improved stock will permit not only increased volume yields (often 10-20%) but also higher quality output. Stand tending, for example, thinning, weed control, and fertilizing will also enhance long-term growth rates of second growth forests. Some form of stand tending is important in ensuring that plantations and natural regenerated areas reach a "free-to-grow" state.

Use of chemicals for control of unwanted weeds in plantations and in some natural stands has expanded from about 7000 ha in 1975 to more than 150 000 ha in 1988. This increase has been due not only to the expansion in area planted but also to the treatment of a larger percentage of the area planted. Again, environmental concerns about the use of herbicides may increase pressure to curtail their use in future. However, alternatives for controlling vegetative competition are limited. Use of manual or mechanical techniques are possible, but often are prohibitively expensive and may be less effective than chemical means.

Table 8. Forest management expenditures in Canada, 1977–1988.

Year	Expenditures current$	Expenditures constant$[a]
	$1 000 000	
1977	660	944
1979	873	1 070
1981	1 248	1 248
1983	1 248	1 094
1985	1 678	1 390
–	–	–
–	–	–
1988	2 016	1 501

[a] Constant dollars (1981 basis) are determined by adjusting current dollars using the gross domestic product (GDP) price index.

Source: Forestry Canada, 1990.

In areas with successful natural regeneration, growth potential can be increased by spacing and thinning to alleviate overcrowding. The amount of area thinned has remained relatively constant since about 1977 at about 50 000 ha per year. Total area of stand tending was about 270 000 ha in 1988.

These increases in planting and tending efforts are reflected in the increased levels of forest management expenditures during the past 10–12 years. Total expenditures have risen from $660 million in 1977 to more than $2 billion in 1988 — a compound annual increase of almost 10% per year. The real rate of increase (after compensating for inflation) has been almost 4% per year (Table 8).

In the past, Canada has been able to rely on "extensive" forest management methods to supply its roundwood needs, that is, reliance on natural regeneration and a massive land base that had not been valued for uses other than growing timber. However, perceptions have changed. We are approaching the limits of the extensive margin in softwood production, and competition for the use of forest land is increasing. However, the high cost of conventional intensive forest management practises poses a major impediment to expanding our timber supply through these means.

4.6 Technological Issues

Technology encompasses the methods and equipment or capital that we use to convert natural resources such as trees to products such as lumber, plywood, and pulp and paper. As our knowledge and capital grow so also does our ability to utilize more raw materials for a broader range of beneficial outputs. Technological advances in Canada's forestry sector have enabled Canada to become among the world's leaders in the production and marketing of lumber, a variety of pulps, and newsprint. This in turn has provided jobs and income for many Canadians.

Technology affects our wood supply in several ways. Its main impacts are felt in the areas of harvesting and processing.

4.6.1 Harvesting

The principal change in harvesting technology since World War II was the introduction of the chainsaw and wheeled skidders. They have substantially reduced the time required in felling trees and removal to a loading area. More recent changes include development of mechanical tree fellers which cut the tree and perhaps de-limb it. This may be combined with an on-site chipper which eliminates the need to haul logs to the mill before chipping. Other innovations include cable systems and using helicopters to improve productivity in logging steep slopes.

These technological developments have had several impacts but the principal effect has been to enable the economical harvesting of smaller, poorer quality trees, possibly in more remote areas, and as a result, effectively extend the wood supply.

Only about half of a tree's total biomass is recovered in today's harvesting operations. The remaining biomass comprises tops, branches, stump, and roots that are considered unmerchantable, as well as losses in the form of decay and damage during logging. In European countries such as Sweden, where the allowable annual cut is fully committed and timber values are very high, some firms have explored full tree harvesting (including branches, tops, and roots) as a means of supplementing wood supply In Canada, there has been an increasing removal of smaller trees and a higher portion of tops but there continues to be considerable biomass left on site.

The decision to harvest low volume stands or remove more portions of a tree depends largely on economic factors. A contributing element, however, is government policy regarding timber utilization. The cost of timber is generally based on the actual volume removed from a particular site, not the total standing volume on the site. Because of the higher cost of extracting the smaller material, the operator will want to remove only the larger more valuable stems and there is no incentive for firms to remove any of the smaller material. However, regulations usually require that trees or tops down to a minimum size be removed.

4.6.2 Processing Technology

The principal timber products produced in Canada are lumber, woodpulp, and newsprint. About three quarters of the roundwood output in this country goes into production of lumber, plywood, and other panels while the remaining one quarter goes directly into pulp and paper production, mainly woodpulp for export and newsprint. However, more than 50% of fiber input for pulp and paper comes from the chips and residue by-products of lumber and plywood production. Thus, of a total industrial roundwood production in 1986 of 170 million m^3, about 125 million m^3 went into solid wood products. Of this 125 million m^3, about 47 million m^3 were used as inputs in the pulp and paper industry in the form of chips, in addition to 45 million m^3 of roundwood.

Technological advances in processing can extend the timber supply by several means. First, by increasing recovery or utilization factors, a larger quantity of product can be produced out of a given size of log. Second, processing innovations permit the use of poorer quality or smaller logs, or in the case of pulp and paper products, the reuse of resources through recycling or the use of wood residues. Third, new products can be manufactured out of previously unmerchantable species or log qualities or sizes.

Solid Wood Products

The availability of high quality logs for lumber has been declining as old growth stands close to the mills have been harvested. However, major technological gains have enabled the use of smaller, poorer quality logs to produce lumber.

The use of computer scanning devices and thinner saws have resulted in higher sawing accuracy and less waste. This has in turn led to a higher lumber yield per unit of roundwood input. For example, in 1970, on average 2.67 m^3 of roundwood were required to produce 1 m^3 of lumber. By 1984, this had dropped to 2.13 m^3. If past trends in productivity continue, we could potentially increase lumber output 5-10% during the next 10 years without increasing the roundwood input.

Development of new products such as waferboard have enabled the use of previously unmerchantable and undesirable species such as aspen. Reconstituted wood products such as laminated veneer lumber permit the use of smaller and lower quality logs in structural products.

Pulp and Paper Products

Principal technological changes in the pulp and paper sector that affect timber supply include increased reliance on recycled pulp, use of a higher percentage of residues or chips, and changes in pulping processes.

Recycling — The increased use of recycled fiber in pulp and paper manufacture has the potential to expand the supply of timber available for other uses because recycled paper substitutes for virgin timber fiber. The degree of potential for substitution is subject to some speculation. For at least the past 40 years, there has been a limited amount of recycled material used in paper and paperboard manufacture in Canada. From 1950 to the early 1970s, secondary fiber made up about 5% of the total fiber input. Since 1970, this proportion has grown gradually and now represents about 10% of the total (Table 9).

Presently there are about 40 paper mills or about one third of all mills in Canada that use recycled paper in their furnish. Estimated total quantity used is 1.9 million metric tonnes or roughly 10% of the total fiber consumption by paper and paperboard manufacturing firms. Approximately one third of the input is imported from the United States, and this proportion has remained about the same during the past 10 years.

The potential for substitution of recycled fiber for virgin fiber in paper and paperboard manufacturing in Canada is difficult to estimate. There are several limitations to using secondary fiber. It is estimated that in 1985, about 20% of Canada's potential recyclable material was recovered (Woodbridge, Reed and Associates, 1988). A major problem regarding collection of waste paper and fiber in Canada is the wide geographic distribution of population, making collection of paper such as newsprint relatively expensive. Apart from the costs involved in collection, there are technical problems in de-inking, de-contaminating because of glues, and separating other materials such as metal and glass. Factors such as legislation requiring a percentage of recycled material to be used in production, quantity, and quality of material available, comparative costs with virgin fiber, and capital costs of facilities such as de-inking plants will all affect the proportion of recycled material used.

Generally, the quantity of recycled fiber used is expected to increase particularly in central Canada for products such as tissue and sanitary paper, linerboard, and newsprint. For each tonne of secondary fiber that displaces pulp as the primary furnish in paper and paperboard production, wood requirements (roundwood or chips) are reduced by approximately 4 m^3. Therefore, if secondary fiber consumption doubled from the 1989 rate of 1.9 million tonnes to 3.8 million tonnes, wood requirements could be reduced by almost 8 million m^3 (or 4% of the current roundwood harvest). In addition, using this material would further reduce pressures on landfill sites.

Utilization of Chips and Residues — By-products of lumber and plywood production include slabs from the outer section of the log, ends, cores, and other trimmed material. This material is suitable for chip and fiber production for pulp and paper use. In 1970, the use of chips and other residues made up about one quarter of the input for pulp and paper production. In 1984, this proportion had more than doubled to greater than 50% (Table 10).

Table 9. Consumption of recycled paper in Canada, 1950–1989.

Year	Recycled paper	Virgin fiber	Total fiber
	1 000 tonnes		
1950	397	–	–
1955	455	7 076	7 531
1960	405	8 013	8 034
1965	511	9 688	10 199
1970	631	11 586	12 217
1975	722	10 025	10 747
1980	1 157	13 522	14 679
1981	1 276	13 759	15 035
1982	1 256	12 359	13 615
1983	1 349	13 170	14 519
1984	1 463	13 998	15 461
1985	1 442[a]	–	–
1986	1 595	–	–
1987	1 695	–	–
1988	1 811	–	–
1989[b]	1 857	–	–

[a] Figures for years 1985–1989 are for Canadian Pulp and Paper Association members only.

[b] Preliminary estimate.

Source: CPPA 1985 and 1989 reference tables.

Table 10. Use of chips and other residues for pulp and paper production in Canada, 1970–1988.

Year	Roundwood	Pulpwood chips[a]	Other residues[b]	Total residues	Total wood
	1 000 m³				
1970	48 339	16 077	1 310	17 387	65 726
1975	39 503	23 142	1 915	24 056	63 559
1980	44 462	37 855	3 819	41 674	86 138
1981	44 717	35 810	3 858	39 669	84 386
1982	38 926	33 411	3 604	37 015	75 841
1983	39 755	39 073	4 280	43 353	83 108
1984	42 597	40 047	4 157	44 204	86 801
1985	44 115	41 026	4 154	45 180	88 295
1986	45 483	42 261	4 403	46 664	92 147
1987	45 539	51 443	4 988	56 431	101 970
1988	46 805	51 519	4 753	56 272	103 077

[a] Purchased chips only.

[b] Edgings, reject lumber, veneer cores.

Source: CPPA 1985 and 1989 reference tables.

The implications of this for timber supply are relatively straightforward — the higher the proportion of sawmill/plywood chips and residues used in pulp and paper production, the lower the quantity of roundwood required. There is a physical limit to this source of fiber, however. Available data indicate that we are currently using about 70% of the total chip/residue material produced. The total volume available depends not only on quantity of lumber and plywood production but also on the conversion process and quantity of by-products produced. As lumber recovery improves through technological innovation, then available chip and residue by-products may decline.

In 1984, lumber and plywood production amounted to about 55 million m^3. Roundwood input was 117 million m^3, resulting in a residual of 62 million m^3. Approximately 70% of this residual or 44 million m^3 was used as chips in pulp and paper production, resulting in a maximum potential increase of 18 million m^3. This represents about 10% of our total current roundwood harvest.

Pulping Process Change — Technological change in pulp processing has a potential major impact on timber supply. In 1987, estimated pulp production in Canada was slightly more than 23 million tonnes. Slightly more than half (56%) of total pulp production was chemical pulp, a large proportion was mechanical (43%), and the remainder was semichemical. The yield of pulp per unit of wood input or recovery rate is approximately 50% for chemical pulp. The semichemical process results in a higher yield (70–80%), while the mechanical processes yield even higher rates (90%+). Thus the quantity of wood input required to produce 1 tonne of chemical pulp is about 5–5.5 m^3, for semichemical pulp about 3 m^3, and for mechanical approximately 2.5 m^3.

While the proportion of mechanical pulp output during the past 15–20 years has not changed significantly, there has been a change in the mechanical process. Chemithermomechanical (CTMP) and thermomechanical (TMP) pulps are replacing traditional stone groundwood pulps. These pulps are stronger and are able to replace chemical pulps in paper products such as newsprint, tissue, and some writing paper grades. Because CTMP and TMP pulps require only about half the wood input of chemical pulps, there is considerable potential gain in saving wood supply through substitution. These processes also allow the use of previously undesirable species such as aspen.

The current wood input requirement for pulp production in Canada is about 100 million m^3 (this includes roundwood, chips, and other residues but excludes recycled fiber). About 70 million m^3 of this goes into the production of chemical pulp and the other 30 million m^3 into groundwood and semichemical pulp. If 10% or 7 million m^3 of wood input were diverted from chemical to mechanical pulp, total output could be increased by about 1.5 million tonnes. Conversely, this substitution would double the wood input availability (7–14 million m^3) because the yield in mechanical pulp is about double that of chemical.

4.7 Changing Physical Characteristics of Timber Supply

The level of AACs and harvests in Canada has risen over time because of several factors. The characteristics of the harvest have also changed over time.

Claims that log quality has declined over time relate to changes in species and size as well as factors such as existence of knots and percentage of clear wood, and are of concern primarily to the lumber industry. Common perceptions are that average log size has been decreasing over time. Part of this is a result of utilization standards having changed over time, requiring firms to extract smaller diameter logs from the forest.

Species composition of the harvest and forest products has also changed. For example, in the early 1960s, more than 22% of softwood lumber production was Douglas-fir and 61% was spruce and balsam fir. By 1986, the percentage of Douglas-fir had dropped to less than 5%, and spruce and balsam fir had increased to 71%. In terms of hardwood lumber, poplars have increased from 5% of the species mix in the early 1960s to almost 20%, while yellow birch and maple have declined from 33 and 34%, respectively, to 24 and 20%, respectively.

A further concern for our future timber supply is that once we start harvesting our second growth forests, the age of trees harvested will be reduced, and thus the size and quality characteristics will decline relative to the current old growth trees. One concern is the higher proportion of juvenile wood in the stem, which is not as desirable for structural purposes.

The quality of our current and future timber supply is difficult to measure or predict in quantitative terms. However, the changes in technology discussed earlier have allowed the use of smaller, lower quality stems as well as different species; as the characteristics of our resource change, new technologies will likely continue to be developed.

4.8 Economic Issues

Canada is currently highly competitive in world production and trade of forest products. For five of the six major product categories, Canada ranks in the top four in terms of percent of total production (Figure 11). We produce almost one third of the world's newsprint volume and rank number one in proportion of output. We produce more than 15% of the world's wood pulp which is second only to the United States in terms of the total. Our softwood lumber production constitutes more than 16% of the world's total, following only the USSR and the United States in ranking. Finally, Canada ranks number four among all countries in paper and paperboard output.

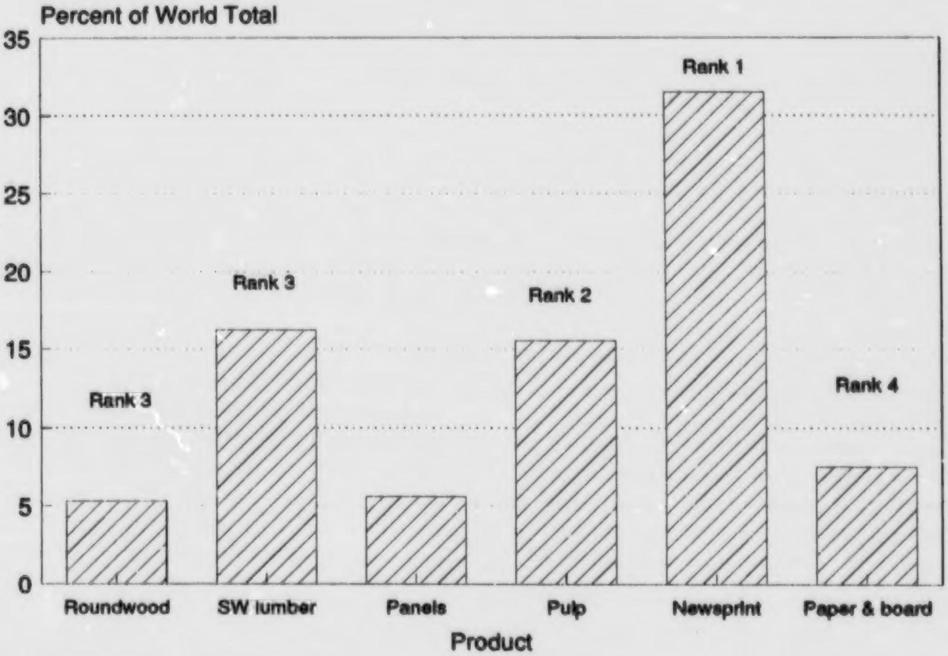


Figure 11. Canada's percentage of world production of various forest products, and ranking (FAO, 1989).

We are a major player in forest products trade. In 1987, more than 60% of the world's exports (by volume) of newsprint, 53% of softwood lumber, 34% of wood pulp, and 24% of paper and paperboard originated in Canada. These products were valued at more than $21 billion or 20% of the total value of world forest products exports. The principal markets for our products outside Canada are the United States, Asia (mainly Japan), and Western Europe (principally the United Kingdom and Germany).

There are several economic issues that affect our timber supply and ultimately our competitiveness on the world market. The interaction of supply and demand for industrial roundwood determines the "equilibrium" price, that is, the price for logs where the quantity supplied equals the quantity demanded. The demand for industrial roundwood is a derived demand — it depends on the demand for end products. Thus the demand for industrial roundwood is a function of the demand for forest products, as well as the cost of roundwood, the cost of substitute inputs, and technological innovation.

The quantity of wood supplied for use in the production of forest products is a function of harvest and delivery costs, the price received for logs, as well as the constraints imposed by AAC policies. Harvest and delivery costs are affected by such factors as transportation distance to the mill, development costs, steepness of the terrain, log size, volumes per hectare, wages, labor productivity, and equipment used.

The quantity and price level of end products such as lumber and pulp very much affect the demand for roundwood, and thus its price. The price received for logs at the mill is also a function of log quality and species prices affect what proportion of our physical timber stock can be profitably harvested.

It has been shown that our current harvest of softwoods is about equal to our AAC and therefore without major changes in factors affecting AAC, further development will not occur. In Canada, prices are likely the main determinant of the economic accessibility of timber. There are substantial areas of timber currently considered economically inaccessible that would enter into the timber supply if prices were to increase.

However, we must make several strategic choices now. We can choose to reduce the demands on the resource by producing such products as printing and writing papers that have significant growth prospects, and yet have a low component of wood costs relative to other products. We can attempt to increase our supply by increasing tree growth and yield by cultural practises such as planting and spacing and improving our protection efforts to reduce losses. We can increase supply by improving utilization in the forests by harvesting a higher proportion of the biomass and by using other tree species, particularly hardwoods. We can reduce the demand for the resource by improving utilization in processing. There are obviously costs associated with these opportunities. Can we afford these costs and remain competitive? This question is difficult to answer because we are only beginning to discover the quantitative impacts of these various factors on the supply of and demand for roundwood, as well as its price.

Because of its position in world markets, Canada is somewhat at the mercy of external market forces. The external pressures of demand for forest products, combined with the static roundwood supplies available at current prices, may result in roundwood price increases. However, there will be increasing alternative sources of supply from nontraditional suppliers such as Chile, New Zealand, and Brazil that can provide roundwood and forest products. These suppliers may keep prices below a level that could allow our economic supply of timber to expand.

4.9 Summary

This report emphasizes the supply of timber available for commercial forest industry use. There is a substantive difference between the amount of physical resource that exists and the amount of timber resource that is economically accessible to the industry. Thus, of the 453 million ha of forest land in Canada, slightly more than half is considered productive and capable of producing a merchantable stand in a reasonable length of time, and only a portion of this productive forest land is likely to be economically profitable to harvest at some time during its rotation length. Although the exact proportion of this economically accessible forest land base is difficult to determine (and is the subject of the second phase of Forestry Canada's Timber Supply Study), each province nets down its forest land base to account, at least partly, for the economic unavailability of some of its resource.

The provinces are responsible for forest resource management and control of Crown lands, which comprise 87% of the stocked, productive, nonreserved forest land. All provinces practise some form of sustained yield management. This means that their planning process attempts to regulate the harvest of timber to maintain a more or less even flow of products during a period of time. The sustainable yield of a particular forest area is related but not necessarily equal to the (partly politically determined) allowable annual cut or AAC. In areas with substantial areas of old growth, the AAC will likely exceed the long-run sustainable yield (LRSY). Ideally, under a sustained yield policy the forest has the same area in each age class up to the age of rotation. Each year the age class at the rotation age is cut. However, Canada's forests are heavily skewed to the older age classes which must be cut over some adjustment period to attempt to approach a "normal" forest. Thus the AAC in the short term will exceed the LRSY in the long term, as these old growth areas are harvested. In most areas, these old growth forests are overmature and would deteriorate and die if they were not harvested. The exception is the British Columbia coast, where old growth forests upwards of 200 years old will remain healthily growing for perhaps centuries.

The provincial AACs and harvests indicate that there is very little potential for industry expansion in softwoods without some actions to increase the extensive margin or increase growth rates. However, there may be regional shortages in one area that are masked by surpluses in another, yet because of transportation costs, it is not economical to transport logs between areas. In addition, the area on which the provincial AAC is based may not truly indicate the forest land base within the extensive margin. If some areas are included in the land base for AAC calculation purposes that are not economically harvestable, then shortages may result. Thus the validity of the assumptions on which the provincial AACs are based are crucial to an evaluation of the timber supply outlook.

One important consideration is the estimated 22 million m^3 of harvest from that portion of private lands for which no AAC has been calculated. A comparison of Canada's total harvest with the aggregate AAC for Canada is thus misleading, and the softwood situation is, in fact, not as tight as this comparison would imply.

Furthermore, as noted earlier, the AAC is calculated based on an estimate of the economically available forest land base, and depends on such factors as growth rates and the age-class distribution. The extent of the economically available land base is not static — it depends on several economic factors. Other institutional, biological, and technological factors may influence the timber supply available.

The AAC is (theoretically) based on all areas within the extensive margin, that is, that area where, at the age of rotation or harvest, the costs of harvesting and delivering a log to a mill are less than or equal to the value or price received for that log. Clearly, the extensive margin will depend partly on the prices of logs and the costs of harvesting and delivery. Costs can be reduced through technological development. For example, mechanization in logging and improvement in road construction have substantially reduced logging costs, hence expanded the extensive margin.

The area within the extensive margin can be expanded in several ways. One is to replant currently unstocked or NSR lands within the extensive margin. Another is to reduce the losses due to pests and fires. Provinces net down their land base to account for natural losses — if these natural losses are reduced, then harvests can replace them. Average annual volume losses from insects, disease, and fire of 145 million m^3 have been estimated.

The area within the extensive margin may also be reduced by several factors. Land alienations to other nonconsumptive forest uses such as parks and to nonforestry uses such as hydro, urbanization, and agriculture reduce the productive accessible forest land base. Degradation of sites because of poor harvesting or road-building practises may take areas out of production. Similarly, long regeneration lags, because of natural regeneration practises or unsuccessful planting, increase the time to maturity of stands and thus reduce the AAC. Regeneration lags are in some cases reduced through the use of chemicals to kill competing vegetation. Environmental concerns about the use of herbicides may result in reduction in herbicide use. Alternatives, such as manual releasing, are substantially more expensive, so the result may be to reduce the area within the extensive margin. Similarly, concerns about the use of pesticides could reduce their use, potentially reducing the area of economically available forest.

Increases in growth rates may cause an increase in AAC. Increases in growth rates may be achieved with intensive forest management, although there is a trade-off in growth increases versus increases in costs. Growth rates may also change because of climatic change (that is, the potential long-term global warming) and acid rain or other pollution induced stresses. The magnitude and even direction of these growth effects are uncertain.

The area of economically accessible timber may also be increased through changes in processing technology and the advent of new products. For example, increased use of hardwoods such as poplar for waferboard and hardwood pulp have increased the extensive margin. (In some provinces such as British Columbia, hardwoods were netted out of the area used to calculate the AAC.) Mixedwood stands containing both softwood and hardwood also become more economical to harvest. Other processing changes, such as the shift from chemical to mechanical pulp, mean that for the same amount of timber input, there is a larger amount of output. This increases the extensive margin by reducing the cost of the input.

Institutional factors affect timber supply in several ways. The type of tenure arrangement affects the management and degree of investment in the resource. These measures can stimulate or discourage investment in forests. The objectives and priorities of governments can have substantial impacts on the resource. Sustained yield objectives will affect investments and the rate of harvest.

Changes in the utilization standards can also increase supply, although at some cost which may mean the once marginal areas are no longer economically viable. Increases in lumber recovery factors reduce the demand for roundwood as do increases in wood residue use in pulp and paper, and the increased use of recycled paper as fiber input into pulp.

Prices, costs, land area, growth rates, protection levels, natural depletions, and institutional constraints change over time. All these factors interact to affect the economically available timber supply in Canada.

5. Conclusions

What are the conclusions we can draw from this report?

1) Canada's timber supply is sustainable in the short run, but may decline in the long run if economic conditions remain static or deteriorate.

2) Economic conditions do not remain static and thus the economically available timber supply is subject to change over time.

3) Many factors influence supply.

4) Although some factors are not within our control, others are, and we can plan strategically to change our future supply situation.

5) The quantitative impacts of these factors on supply are not easy to determine, either singly or in combination.

6) Improved knowledge of the interrelationships between timber supply and these factors are needed so that we can determine where the current and future extensive margin is and how it moves as a result of a variety of factors, particularly price.

The static framework, used in this report to provide a status update on Canada's timber supply, is a useful starting point, but it raises more questions than answers:

1) What should our research priorities be for improving our wood supply situation (for example, cost reductions, silviculture, protection, utilization)?

2) How much and where should we invest in increased wood production and by what means?

3) How will our wood supply change over time in each province?

4) How will different silvicultural regimes affect supply, both in the physical and economic sense?

5) How will changing prices affect available wood supply in each region? What are the impacts of increasing/decreasing logging costs?

6) How will recycling affect the use of the wood resource?

7) How will land use changes affect the use of the wood resource?

8) What are the trade-offs between investments in protection and investments in silviculture to increase supply?

9) How will alternative harvest strategies affect long-term supply?

10) What are the implications of long-run demand for forest products and international competition on our forest resource?

The second phase of Forestry Canada's Timber Supply Study is developing the methodologies and expertise to improve our knowledge of the economics of timber supply. Foremost in the output from this second phase will be a model of economic wood supply that will provide us with an estimate of the current commercially operable land base.

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7. Appendix. Timber Supply Status by Province

Introduction

Wood supply analysis procedures for most provinces have evolved from relatively simple formulas such as Hanzlik's or von Mantel's to considerably more sophisticated, complex simulation and optimizing approaches. Methods vary considerably by province in terms of the planning horizon, inventory projection procedures, and assumptions regarding harvesting rules, stand operability, treatment of insect, disease, and fire losses, etc. Because of changes in land tenure and the acquisition of new data on inventory, biological change, and technology, methods and assumptions in most provinces are constantly changing. Partly as a result of this, it is difficult to obtain up-to-date, comprehensive, published information on methods and assumptions.

The purpose of the synopses that follow is to provide a summary of these methods and some indication of the principal assumptions. Each synopsis includes a brief review of the resource status. This is followed by a review of the principal methods and assumptions used in calculating the AAC, the results or estimated AAC, a comparison of AAC with harvest levels, and finally, an indication of the long-term outlook.

An attempt was made to provide comparable and up-to date information for each province. However, this presented problems. For example, inventory data presented is from *Canada's Forest Inventory 1986* (Forestry Canada, 1989). This information may differ from that used within a province because of differences in definitions, aggregations, timeliness, and so on. Provincial harvest data as reported by Statistics Canada (that is, total roundwood production) was used because a consistent and comparable time series was available for each province from this source. Because of interprovincial log flows, these statistics may not be truly representative of provincial harvests. Furthermore, AACs as calculated by the province are sometimes only for Crown lands, whereas Statistics Canada sometimes includes roundwood production on both Crown and private lands. Information on methods, assumptions, and AAC is presented but analyses are constantly changing, therefore some of the information may already be obsolete.

7.1 British Columbia

7.1.1 The Physical Resource Stock and Its Characteristics

The Forest Land Base

British Columbia has a forest land base of slightly more than 60 million ha or about 65% of its total land area. Slightly more than 45 million ha of this is classified as productive, stocked, and nonreserved (Figure A-1). The remainder is either unproductive or is reserved for wildlife, parks, etc. (Table A-1).

The majority of this forest land base (96%) is provincial Crown land. Less than 250 000 ha is controlled by federal and municipal levels of government and the remaining balance of 1.7 million ha (4%) is privately owned. More than 920 000 ha of private forest land is formally designated as "managed forest land" by British Columbia taxation authorities. The status of the remainder of the privately owned productive forest land base regarding harvesting and forest management is unclear.[1]

The British Columbia forest is still predominantly old growth. In spite of more than a century of harvesting, approximately 28.4 million ha or 63% of the stocked, productive, and available land base is mature and overmature.[2] An additional 1.7 million ha, or 4% of the land base, is in a regeneration phase (defined as less than 20 years old). The balance of the area is primarily in even-aged immature stands ranging from 21 to 120 years old with only a very small residual in uneven-aged stands (Table A-2).

Table A-1. Area classification in British Columbia.

	Area	Percent of Total Land Area
	1 000 000 ha	
Total Land	**92.97**	**100.0**
Forest Land	60.31	64.9
Inventoried	60.31	64.9
Productive	51.10	55.0
Unproductive	9.19	9.9
Unspecified productivity	0.02	–
Noninventoried	–	–
Nonforest Land	32.66	35.1
Water	**1.81**	
Total Area	**94.78**	

Source: *Canada's Forest Inventory 1986* (Forestry Canada, 1989).

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[1] A recent study indicates that private forest land ownership might be as high as 4.1 million ha (Wetton and Associates, 1988).

[2] Mature and overmature stands are defined as those more than 120 years old for all coniferous species except lodgepole and whitebark pine. These species and all deciduous species are considered mature at 81 years (British Columbia Ministry of Forests, 1984).

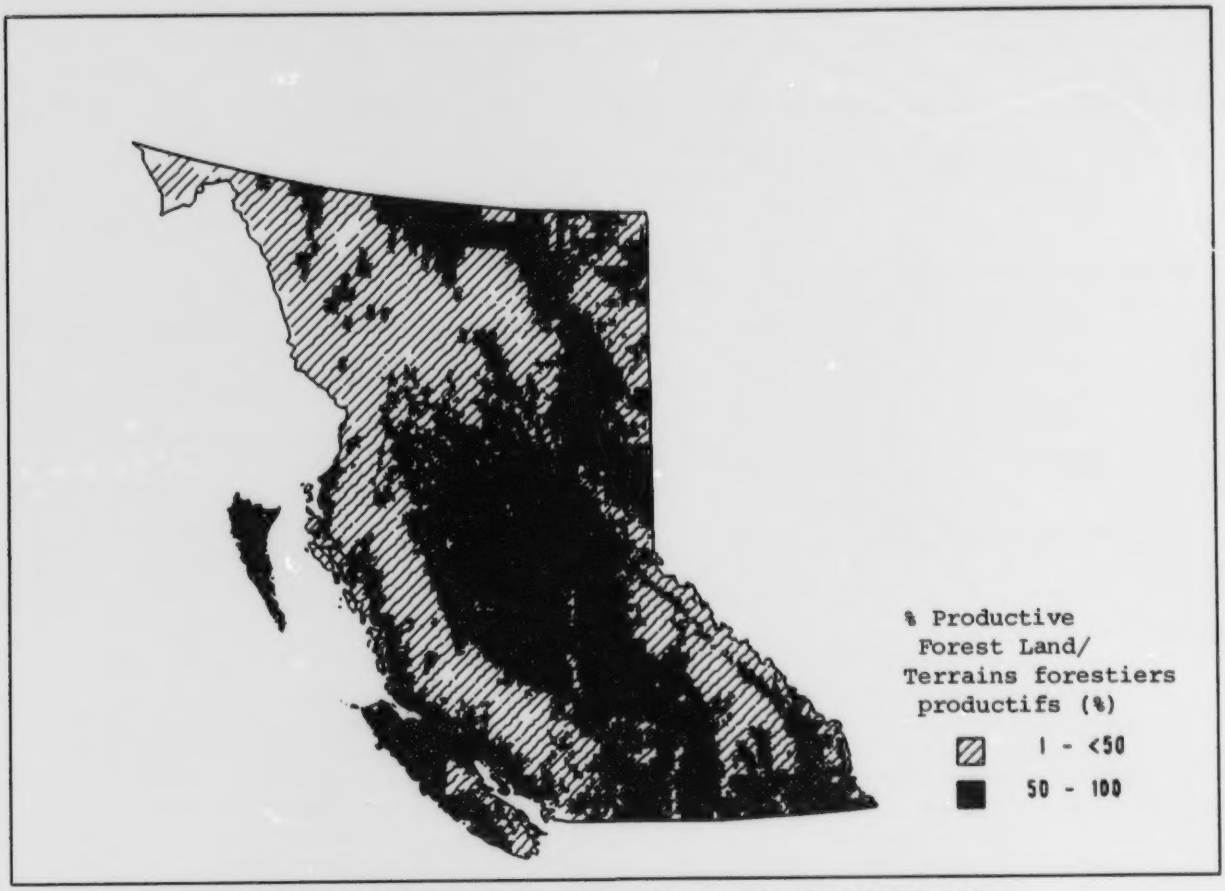
% Productive
Forest Land/
Terrains forestiers
productifs (%)
▨ 1 - <50
■ 50 - 100

Figure A-1. Distribution of productive forest land in British Columbia (Petawawa National Forestry Institute, Forestry Canada).

Table A-2. Area of productive, nonreserved forest land by stocking class and maturity in British Columbia.

Class	Area	Percent of Stocked Area
	1 000 000 ha	
Nonstocked and unproven stocking	**4.04**	**–**
Stocked	**45.05**	**100.0**
Regeneration	1.69	3.8
Immature	15.00	33.3
Mature & overmature	28.36	63.0
Uneven-aged	–	–
Unclassified	–	–
Total	**49.09**	**100.0**

Source: *Canada's Forest Inventory 1986* (Forestry Canada, 1989).

Table A-3. Inventory by species, all maturity classes.

Species	Volume	Percent of Total
	1 000 000 m^3	
Softwoods	**8 180**	**92.3**
Spruce	1 958	22.1
Pine	2 162	24.4
Fir	1 400	15.8
Hemlock	1 217	13.7
Douglas-fir	694	7.8
Other softwoods	748	8.4
Hardwoods	**688**	**7.8**
Aspen/poplar	599	6.8
Birch	50	0.6
Other hardwoods	39	0.6
Total for all species	**8 867**	**100.0**

Source: *Canada's Forest Inventory 1986* (Forestry Canada, 1989).

The Growing Stock

The most recent national inventory data show that there are about 8.9 billion m^3 of growing stock on the productive and available forest land in the province.[3] About 7.3 billion m^3 or 82% of this volume is categorized as mature. The British Columbia Ministry of Forests estimates the mature volume to be somewhat higher. In the Forest and Range Resource Analysis of 1984, the total mature growing stock for provincial Crown lands within Timber Supply Areas and Tree Farm Licenses was estimated to be 7.7 billion m^3, excluding all private and other government lands and some provincial lands that are in the older tenures.

Twenty-eight different commercial tree species are found in British Columbia, in 42 well-defined associations or type groups. In volume terms, spruce, pine, and fir are the predominant species each representing between 16 and 24% of the total. Hemlock represents about 14% of the total volume and Douglas-fir about 8%. The balance consists of cedar, larch, and various other conifers. Deciduous species, mostly aspen and poplar, represent less than 8% of the provincial inventory (Table A-3).

7.1.2 Current Status of Timber Supply (Allowable Annual Cut)

Methods and Principal Assumptions

As of 1988, provincial Crown forest land in British Columbia (96% of total productive forest land) has been divided for administrative purposes among 35 Timber Supply Areas (TSAs) and 33 Tree Farm Licenses (TFLs). Within TFLs, Crown lands are amalgamated with private lands and the licensee is responsible for management and harvesting on the entire land base subject to Ministry of Forests approval. Within TSAs, the Ministry of Forests retains direct management responsibility, while harvesting is allocated to the private sector through several different volume-based tenures.

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[3] This is an estimate of merchantable volume net of decay to provincial "close" utilization standards. For the Coast, this implies harvest to a 22.5 cm dbh limit for all species and a 15 cm top diameter (inside bark). For the Interior, a 17.5 cm dbh limit is assumed except for lodgepole pine which is 12.5 cm dbh Top diameter limit for the Interior for all species is 10 cm (inside bark). On the Coast and in the Interior, close utilization implies harvest to a 30 cm stump height.

For each TFL and TSA, an allowable annual cut (AAC) is set by the province's chief forester, usually for about 5 years. A 5-year "Management and Working Plan" is produced by each licensee. The basis for TSA supply planning is a "Resource Management Plan" produced by Ministry of Forests regional and district staff in consultation with local industry representatives. These reference documents summarize the condition and status of the regional timber resources, and assess and examine the implications for timber supply of a variety of assumptions regarding utilization, economic accessibility, and forest management strategies.

Included in all analyses is a base case scenario that reflects historical practises during the last 5 years regarding operability, utilization, and management within the forest area. Until recently, in the base case scenario, deciduous forest types were 100% removed from the land base for analysis purposes. Other areas are removed from the land base because of environmental sensitivity, because nontimber resource management is a priority, or for implicitly economic considerations. Large areas of forest land are removed from the land base used in AAC determination because of location, terrain, poor stocking, low average height, or overmaturity, which reduces the quality, the volume, or the value of the stands.

In addition to the land allocation process, harvesting and silvicultural assumptions are important elements of the analysis system. In the base case scenario, utilization levels are assumed to be current close utilization standards in the province, with region-specific unavoidable waste and breakage factors applied in each case. In some analyses, minimum cutting ages are assumed to be culmination age to maximize the future volume of production, while in other cases minimum volume and average diameter limits are used to reflect a sawlog economy. Usually, some limitations on accessibility to the net land base are assumed during the next 5 decades to reflect the lack of roads and infrastructure in many areas and the need to leave extensive blocks of mature timber to meet other resource needs. Silvicultural assumptions are reflected in regeneration delays and stand establishment densities. Finally, a series of assumptions are made regarding average unsalvaged losses due to fire, insects, and disease.

The centerpiece of the timber supply analyses is a series of detailed long-run (200-year) forecasts of supply from the planning unit. In the short term (20 years), the existing mature timber stocks are allocated to existing commitments to test the viability of maintaining harvest rates at current harvest levels. In the longer term, a linear programming model is used to develop a harvest schedule that maximizes harvest volumes subject to the various assumptions described previously and the short-term harvest rate. Other constraints on the model include a maximum 10% reduction in the harvest rate from decade to decade and a harvest equal to the long-run sustained yield of the management unit by the end of the planning horizon.

In addition to the base case scenario, several alternative scenarios are developed reflecting different assumptions about the size of the net land base, management strategies, or short-term harvest rates. The specific scenarios examined vary considerably from area to area reflecting local conditions, concerns and opportunities. The implication of each scenario is then compared with the base case to identify significant differences in the projected short- and long-run yields. The intent is to identify the major potential influences on the supply picture in each TSA and TFL.

These timber supply analyses are an input to the AAC determination and do not in themselves set the AAC. The actual AAC is a judgement of the province's chief forester on the basis of this information, discussions with affected parties, consideration of other resource values (such as recreation, fish, and wildlife), and obvious social imperatives for the maintainance and creation of employment.

Table A-4. Land base reductions for TSAs.

Factor	Reduction	Percentage of Land Base[a]
	1 000 ha	
Low productivity site	2 422	6
Deciduous species	3 731	9
Nonsatisfactorily restocked and noncommercial	3 422	9
Environmentally sensitive areas and problem forest types	11 912	28
Total	**21 487**	**52**

[a] Total productive forest land.

Source: Timber Supply Area AAC Rationale Report, Sept. 1985 (British Columbia Ministry of Forests, 1985).

Table A-5. Land base reductions for TFLs.[a]

Factor	Reduction	Percentage of Land Base[b]
	1 000 ha	
Low productivity	23 133	2.3
Deciduous species	24 407	2.4
Nonsatisfactorily restocked	15 999	1.6
Environmentally sensitive areas	20 462	2.0
Problem forest types	72 241	7.2
Total	**156 242**	**15.5**

[a] Based on 10 of 32 TFLs that existed in 1985.

[b] Total productive forest land.

Source: Tree Farm License AAC Report, July 1985 (British Columbia Ministry of Forests, 1985).

The actual AAC may not equal the result of any one forecast provided in a supply analysis. However, once the AAC is set, the reasons for the choice are documented in an AAC Rationale Report. This report outlines the net land base and the other assumptions on which the AAC is based and provides a harvest forecast based on these conditions and assumptions.

Information from the 1985 AAC Rationale Reports is summarized in Tables A-4 and A-5. More than 50% of the 42 million ha of productive forest land in TSAs is not included for AAC calculation. Almost 12 million ha have been removed from the land base because they are environmentally sensitive or they pose problems for commercial harvesting. Other substantial reductions are made because of low site productivity, lack of satisfactory stocking, or deciduous cover. For those TFLs where full information is available, the equivalent reductions only represent 16% of the total productive forest land base. This is because TFL lands tend to represent the more productive and valuable forest land within each region

Current AAC

Table A-6 outlines recent AACs for both TSAs and TFLs in each of six forest regions within the province. The total AAC in 1990 amounted to 74.7 million m^3. About 74% of this (55 million m^3) came from TSAs, with the greatest proportion from the Interior For TFLs, the greatest proportion was from the Coast Region.

Table A-6. Allowable annual cut in British Columbia by forest region and tenure class, 1990.

Region	TSA	TFL	Total
	1 000 m^3		
Cariboo	7 793	110	7 903
Kamloops	7 217	768	7 985
Nelson	5 124	1 509	6 633
Prince George	17 512	1 677	19 189
Subtotal — Interior	**37 646**	**4 064**	**41 710**
Prince Rupert	8 015	1 330	9 345
Vancouver	9 769	13 894	23 663
Subtotal — Coast	**17 784**	**15 224**	**33 008**
Total — Province	**55 430**	**19 288**	**74 718**

Source: Timber Supply Area Summary Report, October 1990, and Tree Farm License Summary Report, March 1991 (British Columbia Ministry of Forests).

The provincial AAC is a composite number arrived at by adding all of the individually approved AACs for TFLs and TSAs. Consequently, the provincial AAC is under constant revision as individual TFL Management and Working Plans and TSA Area Plans are updated. Therefore, the AAC can differ depending on the specific date of the analysis. Obviously, product demand (either for logs or end products such as lumber) will affect the AAC. If product markets are expected to be strong, areas that were considered to be inoperable because of high logging costs will be brought into the land base. In recent years, the total AAC has trended upwards. The AAC for 1981 was 67 million m^3, in 1985 the AAC was 72 million m^3, and in 1990 it had reached 75 million m^3.

7.1.3 AAC Compared with Harvest

Given the approach used in setting the AAC, it should closely relate to the actual harvest from regulated lands in British Columbia. However, flexibility is given to licensees under the British Columbia system to adapt to the markets. Specifically, licensees are entitled to harvest plus or minus 50% of their allowable cut in any given year as long as the average harvest balances within plus or minus 10% of the allowable cut for a 5-year period. Any overcut in a 5-year period is balanced by a corresponding undercut in the next 5-year period.

In addition to the harvest from regulated lands, there is also harvest from unregulated lands in the province. This includes private lands not contained within provincial TFLs, federal land, Indian reserves, and timber licenses not included in provincial TFLs. This latter category represents Crown timber granted in old, so-called temporary tenures during the early part of the century without specific cut controls. After the present old growth inventory of timber is harvested from these tenures, the forest land will revert to regular Crown land status and will fall within the TSA supply planning process.

From 1981 to 1986, the average annual harvest from unregulated lands was approximately 9.1 million m^3. Harvest on unregulated lands for 1987 to 1990 averaged 13 million m^3.

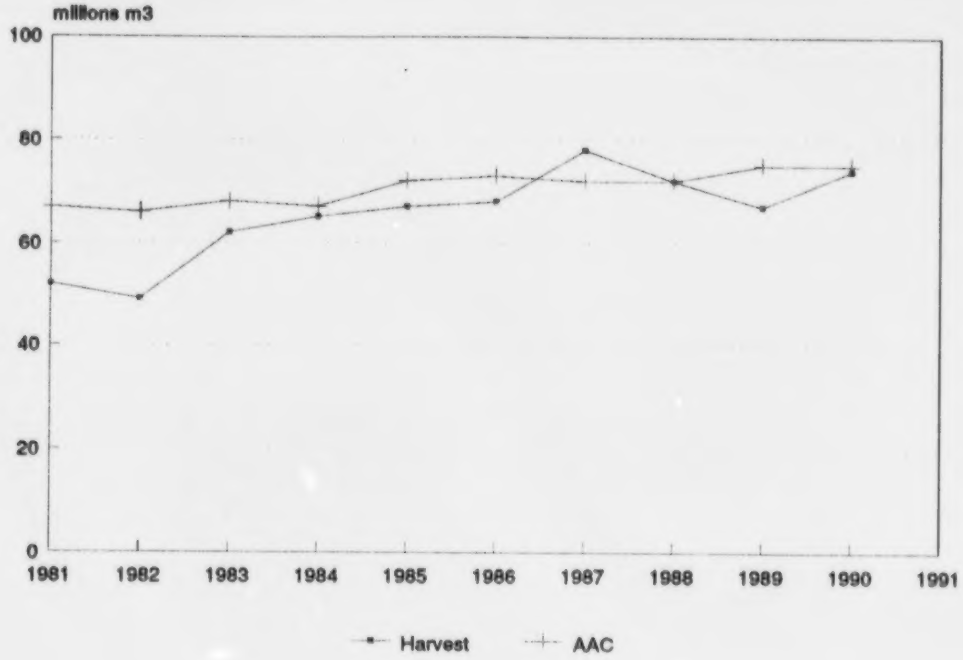

Figure A-2. Roundwood timber harvest and allowable annual cut (AAC) on regulated lands in British Columbia.

From 1981 to 1990, total annual harvest averaged about 76 million m^3. The range of harvests during this period has been from a low of 56 million m^3 during the recession of 1982 to a high of about 90 million m^3 in 1987. The average annual harvest from regulated lands from 1981 to 1990 (65 million m^3) has been very close to the average AAC for those lands (71 million m^3) (Figure A-2). However, the difference between the total harvest and the AAC from regulated lands has been increasing in recent years as greater quantities of timber are being drawn from unregulated lands.

7.1.4 Long-Term Timber Supply Outlook

A key insight into British Columbia's current AAC analysis and the long-term outlook is provided by a clarification of its sustained yield policy presented in the Forest and Range Resource Analysis of 1984. The report states:

> British Columbia's forests are commonly thought to be managed under a policy of constant production over time. This is not true. Many future second-growth stands will yield smaller harvests at maturity than the existing old-growth forests. Application of the sustained yield concept must, therefore, allow for making a transition from using an accumulated inventory of mature timber to relying on annual production from second growth. The general trend is downward to a 'sustainable' level unless productivity is enhanced through more intensive management.

The report also discusses some determinants of timber supply and general trends in their impacts. Changes in harvesting and manufacturing technology have enabled increases in harvest without increased timber growth. However, this is not expected to continue at the same rate. The report says, "The past policy was 'bullish' in that it relied on rapidly improving technology to allow utilization of marginal timber categories as required in the future. That policy prevailed until the mid-1970s when constraining forces on wood supply began to outstrip expanding forces. The 1979 Resource Analysis emphasized that, over most of the province, the above policy would result in serious, long-term consequences for timber supply. It also identified a declining trend in wood supply unless significant investments were made in intensive silviculture."

As a result of this prognosis, "Harvest projections are based on timber supplies that could be utilized economically with existing technology at some time within anticipated market fluctuations. That means, in low or average markets, some of the wood supply will be inoperable, but in peak markets it will be operable. Any additional supplies made operable through improved utilization will be added to the sustained yield supply base if and when they are actually harvested. This will help offset predicted falldowns." (British Columbia Ministry of Forests, Forest and Range Resource Analysis, 1984).

Estimate of long-run sustained yield (LRSY) and the projected time path toward them from recent harvest levels are also provided in the AAC Rationale Reports. Comparisons of the LRSY with the current AAC as of 1990 are provided in Tables A-7 and A-8.

As shown in Table A-7, in 1990 the estimated LRSY for TSAs was about 22% lower than the AAC. The extent of this anticipated reduction varied by forest region with the largest decline expected to be in the Prince Rupert region and the smallest in Prince George. The timing of these anticipated reductions varied considerably by region and TSA. In some TSAs, projections indicated that harvest at the current AAC level could be maintained for 200 years. In other areas dramatic adjustments in harvest rates were projected within the next several decades. However, at an aggregate provincial level the harvest was projected to gradually trend toward the LRSY over a 200-year planning horizon. The forecast adjustments during the first 50 years were not substantial. The forecast adjustments were more dramatic during the next 50 years and reached a peak between 100 and 150 years into the projection.

Table A-7. Comparison in 1990 of long-run sustained yield (LRSY) and allowable annual cuts (AAC) for Timber Supply Areas.

Region	AAC	LRSY	LRSY as Percent of AAC	Range of Percentages
	1 000 m^3			
Cariboo	7 793	5 473	70	61–106
Kamloops	7 217	5 892	82	70– 91
Nelson	5 124	4 097	80	38– 96
Prince George	17 512	15 026	86	70–102
Subtotal — Interior	**37 646**	**30 488**	**81**	-
Prince Rupert	8 015	5 057	63	24–102
Vancouver	9 769	7 415	76	49–103
Subtotal — Coast	**17 784**	**12 472**	**70**	-
Total	**55 430**	**42 961**	**78**	**24–106**

Source: Timber Supply Area Summary Report (British Columbia Ministry of Forests, 1990).

Table A-8. Comparison in 1991 of long-run sustained yield (LRSY) and allowable annual cut (AAC) for Tree Farm Licenses.

Region	AAC	LRSY	LRSY as Percent of AAC	Range of Percentages
	1000 m^3			
Cariboo	110	94	85	–
Kamloops	768	630	82	76–92
Nelson	1 509	1 017	67	44–124
Prince George	1 677	1 569	94	76–98
Prince Rupert	1 330	1 199	90	71–115
Vancouver	13 894	12 356	89	68–152
Total	**19 288**	**16 866**	**87**	**44–152**

Source: Tree Farm License Summary Report, March 1991 (British Columbia Ministry of Forests, 1991).

Table A-8 shows that the anticipated reduction in TFL harvests in the long term is slightly less than for TSAs. Again, the forecast indicated that on an aggregate basis, this will be gradually affected during a 150-year period. However, the reductions in some individual TFLs were projected to be more severe and to occur considerably earlier.

Although these forecasts deal with regulated lands, there is considerable uncertainty about the potential future harvest from unregulated lands. Like the harvest from regulated lands, the level of harvest from unregulated tenures is not considered to be sustainable at present levels. Private lands outside of provincial TFLs are likely to be depleted of old growth at some point and little or no information exists on future sustainable harvest levels. Similarly, the old temporary tenures will be depleted of old growth within the next 20–30 years. The future contribution of this land to the AAC in TSAs is likely to be lower than the current rate of depletion.

Sensitivity of Forecasts to Assumptions

The provincial supply analysis indicates that the expected future harvest is somewhat lower than the current AAC/harvest level. This is largely due to the movement from an old growth, high volume forest to second growth, low volume stands. Whether this will actually occur will depend on a wide variety of factors. This long-term outlook is quite sensitive to a host of assumptions including growth and yield estimates, silvicultural inputs, land use change, losses due to insects and disease, etc. Recent TSA analyses completed by the province provide some indication of the sensitivity of the supply forecasts to these assumptions. Table A-9 compares results for four different management scenarios. These data are based on a sample of eight TSA analyses which have recently been updated. (Since most TSA analyses were done in 1981, results reflect management and utilization differences since that time.) Scenarios shown in Table A-9 are described as follows:

1) Revised AAC Rationale — This scenario represents changes over the previous AAC analysis or base case due to updated inventory and growth information.

2) Status quo — This scenario represents actual utilization and management (silviculture) practises during the last several years. Differences between this and the AAC Rationale reflect differences between actual utilization and management and that assumed in the previous forecasts.

Table A-9. Sensitivity of harvest and LRSY projections to alternative management and utilization assumptions for selected TSAs.

Scenario	Net Land Base	Current AAC	Average Short-Term Harvest[a]	Average Long-Term Harvest[b]	LRSY
	1 000 ha	1 000 m^3			
AAC Rationale	3 259	10 050	10 050	8 996	8 480
1) Revised AAC Rationale	3 282	10 050	9 942	8 651	7 937
2) Status quo	2 717	10 050	8 121	7 030	6 927
3) Nonconventional harvesting/ increased utilization	3 418	10 050	10 101	9 058	8 850
4) Enhanced silviculture	3 052	10 050	9 257	8 759	8 950

[a] Years 1–20.

[b] Years 1–200.

Source: Selected TSA Reports (British Columbia Ministry of Forests).

3) Nonconventional harvesting/increased utilization — This represents a variety of changes including harvesting older, overmature timber, reducing unsalvaged losses, cutting smaller trees, harvesting stands with lower volumes, etc.

4) Enhanced silviculture — This includes increases in activities such as backlog reforestation, juvenile spacing, fertilization, etc. In specific terms, the enhanced silviculture scenario appears to represent an average threefold increase in silvicultural expenditures over the status quo scenario.

Results for these eight TSAs show that updated inventory and growth information since the previous AAC calculation has reduced the LRSY of the resource. Due to reclassification of some of the land base in terms of growth potential and a revision of growth estimates, the long-run productivity of the land base is assessed somewhat lower. Under the status quo scenario, the net land base has been reduced substantially. This indicates that actual utilization of the forest land base during the last 5 years has been considerably less than anticipated when the AAC was set. If this continues, it is anticipated that short- and long-term harvests and the LRSY will be reduced.

The main impact of changes in harvesting and utilization practises (scenario 3) is an increase in the net land base, substantially increasing harvests and LRSY. Finally, results show that while the effect of enhanced silviculture is primarily in the long run, short-term or allowable cut effects are expected as well. The impacts of the enhanced silviculture and the increased utilization scenarios are not strictly additive. However, a combined scenario would have dramatically greater impacts than either alone. Both scenarios show that there is considerable potential to maintain or even increase harvests above current AAC in the short term and to ameliorate any falldown in long-run harvest levels. However, this will require changes in harvesting, utilization, and/or silviculture objectives, and strategies from those currently pursued.

7.1.5 Conclusions

The size of the British Columbia forest resource is truly impressive. In purely physical terms, there is little shortage of wood in the province. The estimated volume of mature timber currently available for harvesting is sufficient to maintain recent average harvest rates for many decades. The major problem lies in the quality and condition of this resource, the limited accessibility in many regions, the generally difficult operating terrain throughout much of the province, and the imperatives of other competing uses for the land base and growing stock including parks, wildlife, and wilderness areas. As a result, only a portion of this immense resource is available and economically exploitable now.

The AAC in British Columbia is set while clearly recognizing the various factors that can affect supply. It is a judgement at a point in time by the province's chief forester based on the wide range of information contained in the supply analyses.

The most recent analyses indicate that harvests from regulated lands are likely maintainable at recent levels for several decades. Harvest levels are currently above the LRSY in most regions and in the long term, harvests are projected to decline by about 14–25% from current levels during a 200-year period. This is a result of the change from harvesting primarily old growth, high-volume stands, to younger, lower volume stands. However, certain areas are already facing local shortages of wood and reduced harvest levels.

As illustrated in the scenarios of the previous section, there are opportunities for offsetting this falldown of harvests over time through reforestation of NSR lands, increased protection to reduce insect and fire losses, improved utilization, intensive silviculture, and harvest of currently inoperable lands. Increasing demand for hardwoods is already expanding the available stock of mature, economically accessible timber. Increased log prices, or reduced costs through changes in technology or transportation infrastructure, could increase the proportion of the resource that is economic to harvest. Improved information on growth and yield of managed and unmanaged stands could also result in changes to LRSY estimates.

Increasing harvesting constraints, and reallocation of productive forest lands to nontimber uses could reduce LRSYs further. The increasing pressure on British Columbia's forest land base from competing land uses is currently causing a major uncertainty about the future land base that will be available for commercial harvesting.

There is also a major uncertainty regarding future timber supply from unregulated lands in the province. Although private and other unregulated tenures represent a very small proportion of the forest land base of the province, in recent years they have contributed between 12 and 16% of the annual harvest. The sustainability of these harvest levels will have a major influence on the adequacy of the future timber supply in the province.

7.2 Alberta

7.2.1 The Physical Resource Stock and Its Characteristics

The Forest Land Base

Alberta has a land area of 64 million ha (Table A-10). Of this total, almost 60% or 38 million ha is classified as forest. Of this, 25 million ha are considered productive (Figure A-3) and only 19 million are nonreserved and stocked. The majority of nonforest land is classed as agricultural.

Approximately 90% of the inventoried productive forest land (25.4 million ha) is owned by the provincial government, 7% by the federal government, and the rest is private.

Slightly more than half the productive, stocked, and nonreserved forest land is occupied by mature and overmature timber. An additional 46.8% is classified as immature, and the remainder is in the regeneration class (Table A-11). The large proportion of area in the immature age classes is partly due to severe fire losses from 1925 to 1945. More than 3.5 million ha were burned during this period (Murphy, 1985).

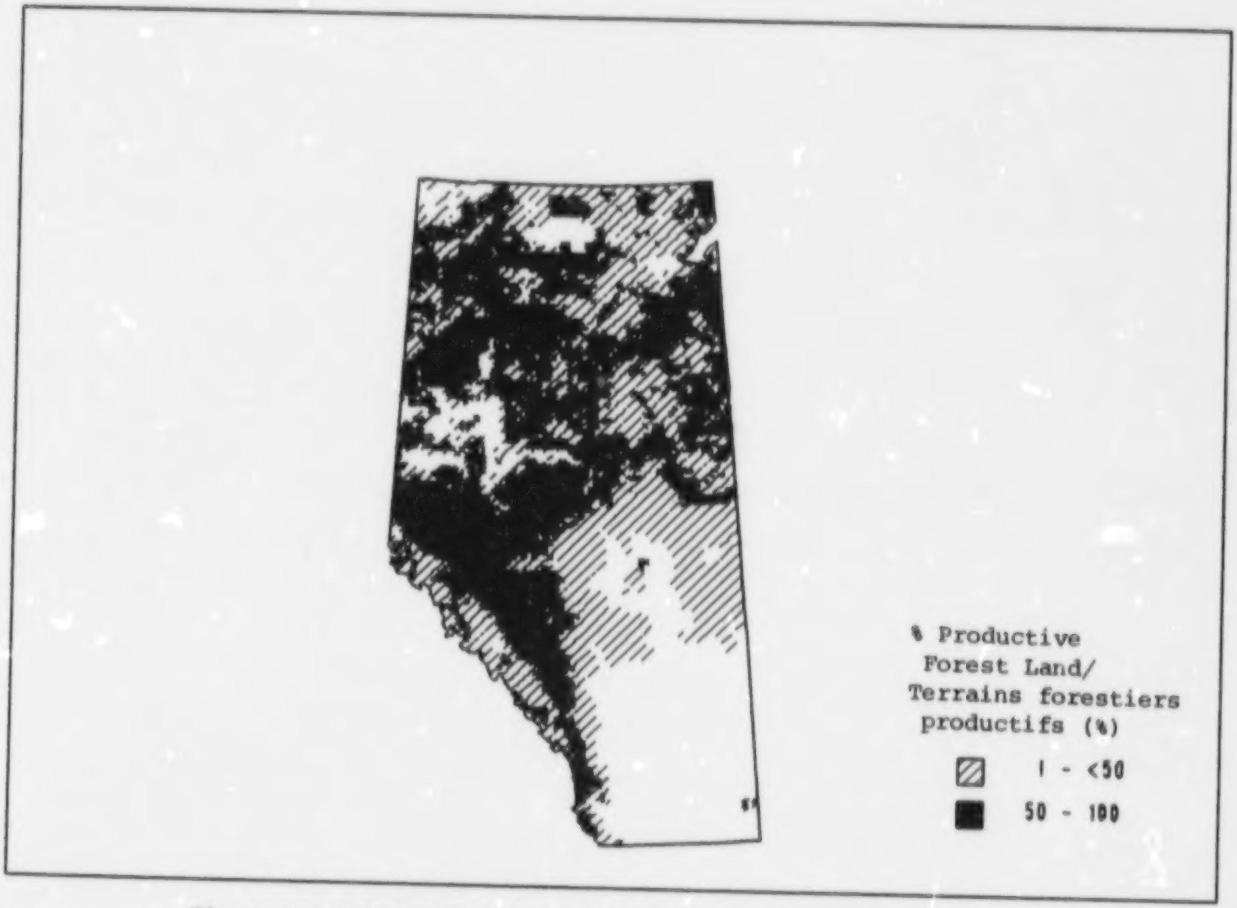

Figure A-3. Distribution of Alberta's productive forest land (Petawawa National Forestry Institute, Forestry Canada).

Table A-10. Area classification in Alberta.

	Area	Percent of Total Land Area
	1 000 000 ha	
Total Land	**64.44**	**100.0**
Forest Land	37.75	58.6
Inventoried	37.75	58.6
Productive	25.44	39.5
Unproductive	11.82	18.3
Unspecified productivity	0.49	0.8
Noninventoried	–	–
Nonforest Land	26.69	41.4
Water	**1.68**	
Total Area	**66.12**	

Source: *Canada's Forest Inventory 1986* (Forestry Canada, 1989).

Table A-11. Area of productive, nonreserved forest land by stocking class and maturity in Alberta.

Class	Area	Percent of Stocked Area
	1 000 000 ha	
Nonstocked and unproven stocking	**2.38**	–
Stocked	**19.08**	–
Regeneration	0.30	1.6
Immature	8.93	46.8
Mature & overmature	9.86	51.7
Uneven-aged	–	–
Unclassified	–	–
Total	**21.46**	**100.0**

Source: *Canada's Forest Inventory 1986* (Forestry Canada, 1989).

The Growing Stock

Alberta forests encompass 12 ecoregions. Six of these ecoregions are considered to be forested systems with continuous overstories. On the basis of commercial value and total area, the boreal mixedwood is the most important followed by boreal foothills, boreal uplands, and subalpine. The boreal mixedwood ecoregion is Alberta's largest, representing 43% of the province. This region occurs in the northern half of the province except for a broad strip along the NWT/Alberta border (Strong and Leggat, 1981). Aspen is the dominant tree species; however, balsam, poplar, black spruce, white spruce, and jack pine are also common.

The boreal foothills region occurs west of the mixedwood. Principal species are aspen, poplar, and lodgepole pine. The uplands region occurs in the west central part of the province. White and

Table A-12. Inventory by species, all maturity classes in Alberta.

Species	Volume	Percent of Total
	1 000 000 m³	
Softwoods	**1 684**	**63.4**
Spruce	920	34.6
Pine	695	26.2
Fir	47	1.8
Other softwoods	22	0.8
Hardwoods	**972**	**36.6**
Aspen/poplar	822	30.9
Birch	33	1.2
Other hardwoods	117	4.4
Total for all species	**2 656**	**100.0**

Source: *Canada's Forest Inventory 1986* (Forestry Canada, 1989).

black spruce are the principal climax species. The absence of aspen in the boreal uplands region distinguishes it from the foothills. Finally, the subalpine region is characterized by the occurrence of Engelmann spruce and Engelmann spruce/white spruce hybrids.

On an area basis, the age-class structure of stocked forests is dominated by immature and mature/overmature stands. Virtually all forests are even-aged which reflects the important historic role played by fire in forest ecology.

Softwoods make up almost two thirds of the total volume for all species (Table A-12). The predominant species in this group are the spruces and pine. Aspen and poplar comprise most of the hardwood volume.

7.2.2 Current Status of Timber Supply (AAC)

Methods and Principal Assumptions

The authority for designating the provincial AAC rests with the Timber Management Branch of the Alberta Forest Service (AFS). This authority is exercised via the approval of industry AACs on Forest Management Agreement (FMA) areas, and the calculation of the AAC for all remaining management units in the "Green Area." Regulatory guidelines for establishing rates of timber flow are based on a general policy of nondeclining yield. Three separate time series are used for timber supply planning. The **conversion period (CP)** is the length of time required to harvest the existing inventory and is usually set at one full rotation.[1] The **postconversion period** is the time from the end of the conversion period to the end of the second rotation. The **planning horizon** combines the conversion and postconversion periods.

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[1] Rotations are set on the basis of culmination of mean annual increment with an allowance of 10% maximum loss. Regeneration lag is incorporated by reducing anticipated volumes. For example, on stands with 80-year rotations and a 4-year regeneration lag, expected yield at 76 years would be used. Currently, a single weighted rotation age is used to calculate AAC on non-FMA lands. FMA holders use separate rotations depending on species and site combinations.

Generally, five types of harvest levels are determined in the supply analysis: (1) nonsustainable conversion period harvest, (2) sustainable conversion period harvest, (3) postconversion period harvest, (4) planning horizon harvest, and (5) long-run sustained yield average. Although all five estimated harvest levels are considered when setting harvest flows, the AAC reflects the maximum sustainable harvest during the conversion period.

An important policy consideration is treatment of variations in actual periodic harvest rates. According to this policy, decade to decade harvests are maintained at the average conversion period harvest rate and the postconversion period harvest is used in setting the current AAC. Thus falldowns (for example, the nonsustainable conversion period average rate minus the sustainable conversion period rate) are not included in the approved estimates of AAC. Falldown volumes are designated as "surge cuts" and are disposed of through short-term timber permits. In AFS analyses, the postconversion period harvest cannot be less than the last decade harvest of the conversion period. The postconversion period harvest is not constrained to equal the long-run sustained yield average (LRSY) level. For FMA holders who constrain the postconversion period at the LRSY level, any falldown after the first rotation must be addressed by the company through intensive forest management. For both FMA holders and the province, the initial step in determining the AAC is to "net down" the land base by reviewing stand level information such as volume (stand must be capable of producing 50 m^3/ha at 140 years for conifers, and 120 years for deciduous), elevation (for example less than 1980 m), and slope (less than 45%). Additional areas are withdrawn for ecological reserves, integrated resource planning constraints, etc. An AAC for the net land base in each forest management unit (FMU) is determined by a variety of methods including the Area-Volume Check and the Timber RAM model.

This AAC represents a gross estimate and is further reduced by accounting for fire loss (discussed later under sensitivity of AAC) and utilization standards. The final setting of AAC for the FMU is a management decision. The various Timber RAM and Area-Volume Check estimates are plotted over the planning horizon and submitted to the director of the Timber Management Branch for review. Other factors such as demand for timber, final age-class distribution, and nondeclining yield policy are then used to evaluate alternative AAC levels.

AACs for FMUs are generally reviewed every 10 years except for those units in which the AAC is approaching full allocation. In these situations, the AAC may be reviewed every 5 years. Where catastrophic events have occurred, the AAC would be reviewed immediately.

Current AAC

Total AAC in Alberta is more than 26 million m^3 (Table A-13). Approximately 57% of this AAC volume is coniferous and the remaining 43% deciduous. The majority of this AAC is considered economically accessible.[2]

Currently, 90% of the coniferous AAC and 78% of the deciduous AAC is allocated to the forest industry. Provisional commitments include allocations to projects approved, or under construction such as the Alberta newsprint mill at Whitecourt, the Daishowa bleached kraft pulpmill near Peace River, and other operations.

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[2] Although the netting down of the land base and AAC calculations do reflect some economic parameters such as resource characteristics and end product markets, other factors such as accessibility (with exception noted later), distance to processing sites, and markets are not considered in the AAC estimation. The economically inaccessible volume shown in Table A-13 represents volumes in areas in the extreme north of the province.

Table A-13. Allowable annual cut, allocation, and reserves of timber in Alberta, 1989.

	Total AAC	Allocated AAC	Provisional Commitment	Physical Reserve	
				inacc.	access.
	1 000 m³				
Coniferous	15 052	13 614	474	281	683
Deciduous	11 594	9 001	2 089	93	411
Total	26 646	22 615	2 563	374	1 094

Source: Alberta Forest Service, Timber Management Branch, 1989.

7.2.3 AAC Compared with Harvest

The preceding table shows the allocated AAC for 1989; however, the actual cut has been considerably lower. For example, in 1986/87 the total cut from provincial Crown lands was 8.230 million m^3 (7.429 million m^3 softwood and 0.801 million m^3 hardwoods). In addition, 0.250 million m^3 was harvested on federal lands. As in most provinces, harvest has been increasing over time relative to AAC (Figures A-4 and A-5). (Note that harvests are based on Statistics Canada, roundwood production, which includes production from all lands.) During the past 10 years, total softwood roundwood production in the province has increased from 5.5 million m^3 to more than 9 million m^3.

Also, as previously mentioned, several major forest industry developments have either come on stream since 1985 or are planned in the near future. If all the proposed developments are implemented, approximately 95% of Alberta's total AAC will be fully committed by the mid- to late 1990s.

7.2.4 Long-Term Timber Supply Outlook

As indicated in the section on AAC calculation, various harvest levels are calculated for different time periods including conversion, postconversion, and the planning horizon. Also, the present government flow policy requires that for long-range planning, the average conversion period harvest must be equal to or below the postconversion (second rotation) period. For this reason, AACs shown in Table A-13 reflect the long-term outlook. Estimates of long-term supply depend on a certain level of management input. Declines in the level of silviculture or forest protection, for example, could reduce future timber supply.

Sensitivity of Forecasts to Assumptions

Harvest levels are highly sensitive to the type of planning model used as well as the various assumptions incorporated within the model. In Alberta, several management-related assumptions are considered in the determination of allowable harvest. These assumptions include (1) the time required to grow a stand to maturity, (2) expected yields from second rotation stands, (3) proportional reduction of AAC to account for fire loss, and (4) expected changes in forest inventory over time.

The assumed lag for regenerating stands with timber supply planning in Alberta is 4 years for coniferous stands, and 0 for deciduous stands. However, research for one particular management unit showed that an increase in the lag time for regeneration from 0 to 10 years can reduce long-run sustained yield average harvest by 15%. The conventional wisdom that coniferous plantations are

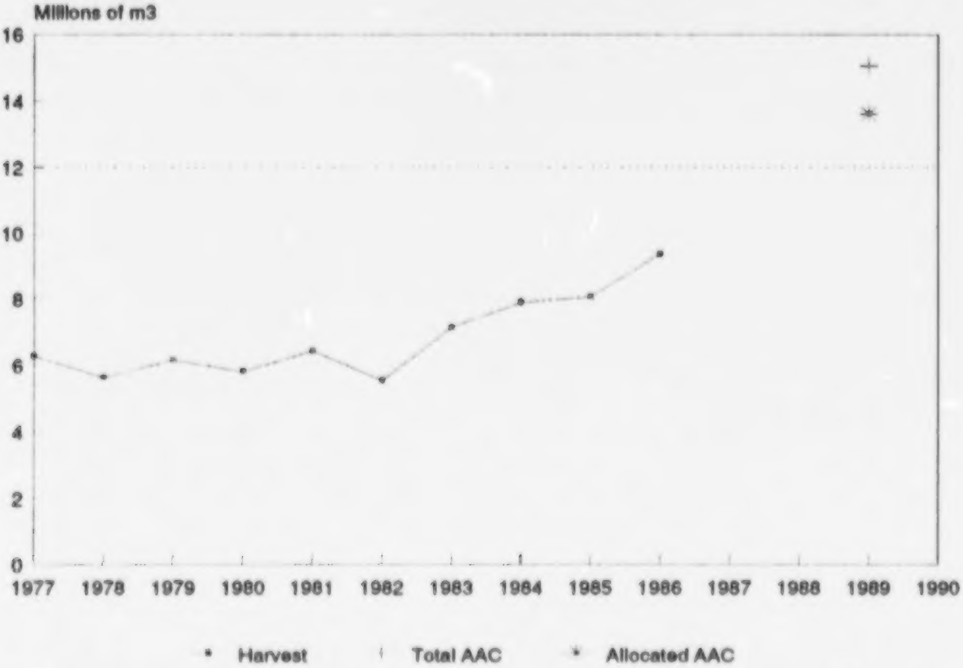


Figure A-4. Softwood timber harvest and estimates of AAC and allocated AAC in Alberta.

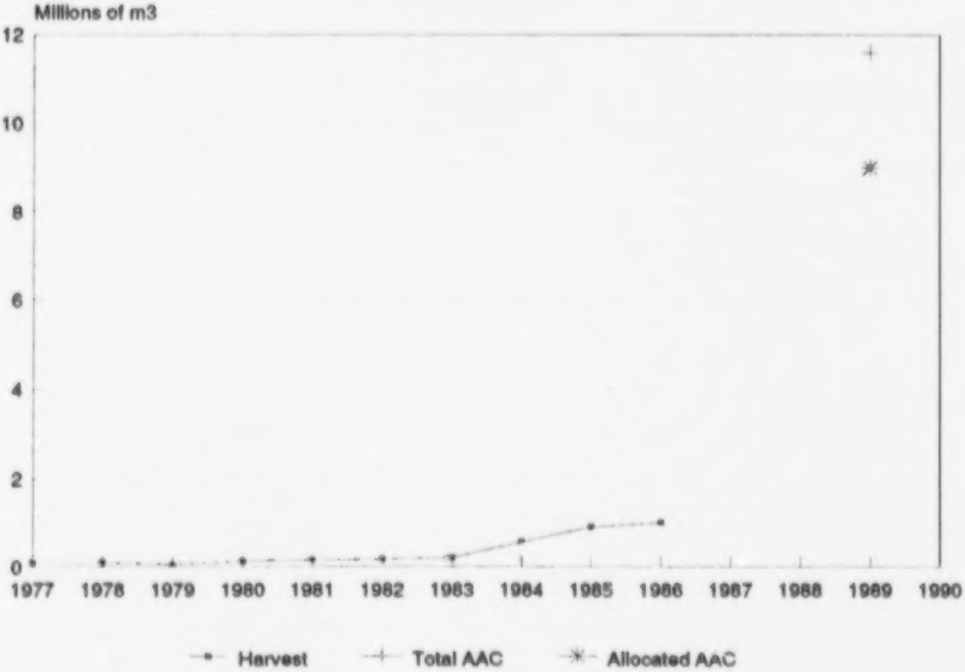


Figure A-5. Hardwood timber harvest and estimates of AAC and allocated AAC in Alberta.

"free to grow" following initial establishment is being challenged. Surveys of juvenile stands in Alberta have indicated that stands considered by the supply model to be satisfactorily stocked at 10 years may actually be either out of production or subject to longer rotations than planned. This factor could lead to overestimates of the coniferous harvest potential. Monitoring of regeneration performance will continue in the future. Regeneration assumptions will be reviewed when the flow policy is reviewed.

The expected yields of regenerated stands have a direct effect on current AAC since estimates of the long-run sustained yield average (LRSY) are considered when setting AAC. For harvest planning, an implicit assumption is that yields from regenerated stands are equivalent to the fully stocked cover type yield. Dempster and Goudie (1984), however, point out that "... examination of real time series data, such as permanent sample plot remeasurements and height growth data from stem analyses, casts serious doubt on this assumption". Some concern exists about the reliability of projected yields based on current approaches; however, present alternative methods are not yet operationally viable.

Fire depletion in the AAC determination is accounted for deterministically by applying a fire loss allowance factor to the gross AAC. The average volume burned per year is based on a 22-year average burn rate calculated for each forest area. The average area burned is used to estimate an average volume loss. The AAC is then reduced accordingly. A maximum of 10% of the AAC volume is allowed as a reduction. This approach precludes any possibility of gains to timber supply through improved detection and suppression.

The last key factor considered in timber supply estimation is the development of the forest inventory over time. Current harvest planning methods use the existing inventory as the basis for making projections over 200-year planning horizons. This approach assumes that (1) the AAC is fully utilized; (2) old stands are replaced by new stands with similar species composition; (3) mixedwood and deciduous stands develop into coniferous stands where an identifiable coniferous understory exists; (4) plantations are free to grow; (5) the land base, level of management inputs, and the technology of tree crop production remain constant; and (6) future climatic influences are similar to historic patterns.

The AAC estimates are clearly sensitive to the various assumptions discussed previously. Given current knowledge and the state of existing data bases, estimates of timber supply are the best available.

7.3 Saskatchewan

7.3.1 The Physical Resource Stock and its Characteristics

The Forest Land Base

Saskatchewan ranks fifth in Canada in terms of inventoried productive forest land with almost 16 million ha (Table A-14). This area, however, constitutes only about 28% of the total land area in the province. By comparison, land classed as agricultural totals 26.6 million ha or almost 47% of the total land area.

Virtually all this productive forest land (15 million of 15.98 million ha, or 94.6%) is classified as provincial Crown lands. A small portion (about 3%) is owned by the federal government, and the remainder is private.

Unlike many other Canadian provinces, the majority of Saskatchewan's forest land is stocked with younger age stands (Table A-15). Almost 50% of the stocked productive forest land supports regeneration or immature stands. This age-class structure reflects the high occurrence of wildfire.

The Growing Stock

Although the northern half of the province is classified as forest, the majority of productive forest land is located in the center one third of the province (Figure A-6). The primary forest region is the mixedwood subregion of the Boreal Region. A large portion of this subregion is covered, in order of prevalence, with pure aspen, jack pine, and black spruce stands, as well as mixed white spruce–aspen stands. Just to the immediate south of the center third lies the aspen grove subregion which is a transition zone from boreal forest to grasslands. The main species are lodgepole pine and aspen in pure or mixed stands.

Table A-14. Area classification in Saskatchewan.

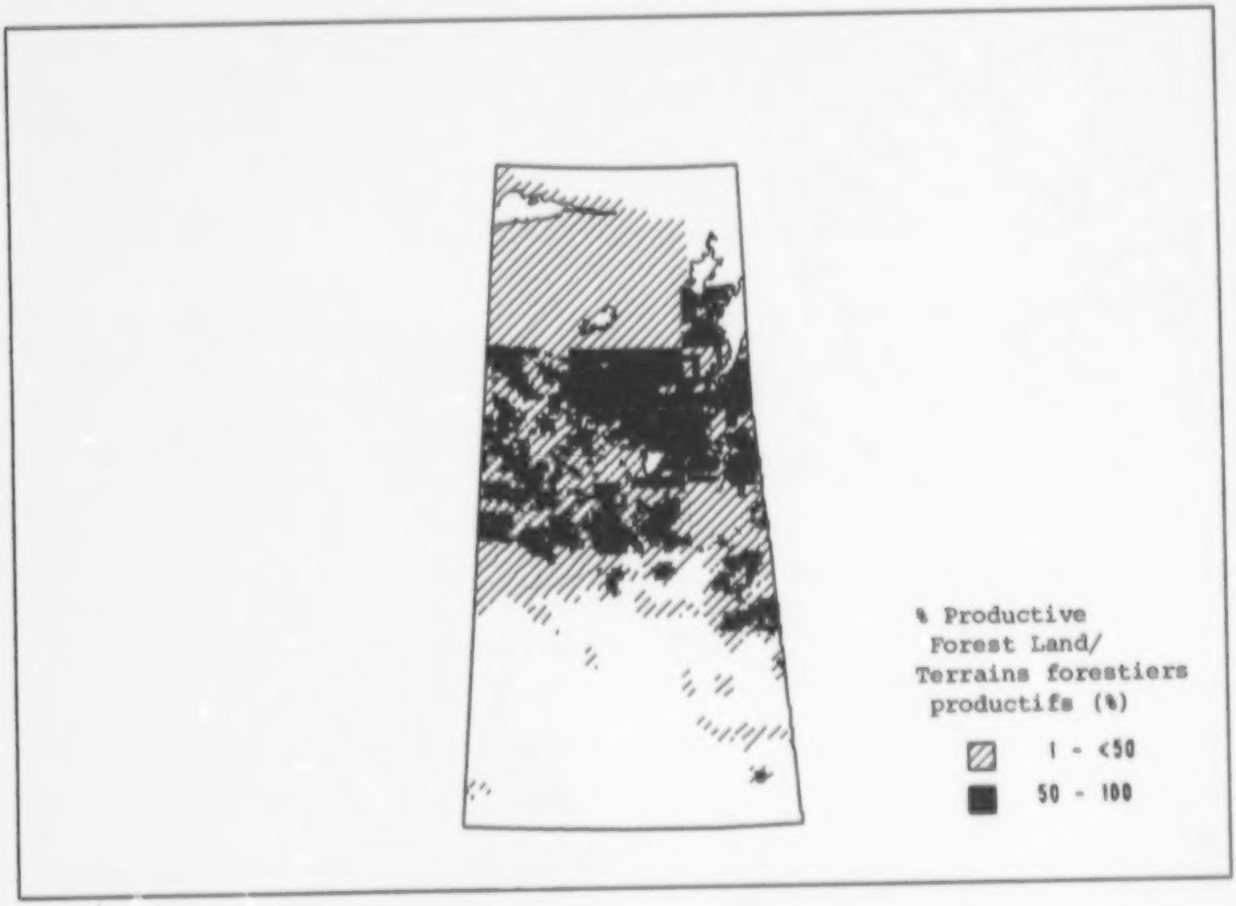
	Area	Percent of Total Land Area
	1 000 000 ha	
Total Land	**57.07**	**100.0**
Forest Land	23.71	41.5
Inventoried	23.71	41.5
Productive	15.89	27.8
Unproductive	7.80	13.7
Unspecified productivity	0.02	0.0
Noninventoried	–	–
Nonforest Land	33.36	58.5
Water	**8.16**	
Total Area	**65.23**	

Source: *Canada's Forest Inventory 1986* (Forestry Canada, 1989).

Table A-15. Maturity class of productive, stocked, and nonreserved forest land in Saskatchewan.

Class	Area	Percent of Stocked Area
	1 000 000 ha	
Nonstocked and unproven stocking	**1.50**	-
Stocked	**13.32**	**100.0**
Regeneration	1.07	8.0
Immature	5.37	40.3
Mature & overmature	2.44	18.3
Uneven-aged	-	-
Unclassified	4.44	33.3
Total	**14.82**	-

Source: *Canada's Forest Inventory 1986* (Forestry Canada, 1989).


% Productive
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Terrains forestiers
productifs (%)
▨ 1 - <50
■ 50 - 100

Figure A-6. Distribution of Saskatchewan's productive forest land area (Petawawa National Forestry Institute, Forestry Canada).

Table A-16. Inventory by species, all maturity classes in Saskatchewan.

Species	Volume	Percent of Total
	1 000 000 m³	
Softwoods	**536**	**59.2**
Spruce	205	22.7
Pine	130	14.4
Fir	13	1.4
Other/unspecified	188	20.8
Hardwoods	**370**	**40.9**
Aspen/poplar	289	31.9
Birch	22	2.4
Other/unspecified	59	6.5
Total	**905**	**100.0**

Source: *Canada's Forest Inventory 1986 (Forestry Canada, 1989).*

The subarctic and northern subregions occupy the northern one third of Saskatchewan. These areas are dominated by black and white spruce, and jack pine. Intermixed with these species are balsam fir, tamarack, trembling aspen, and white birch. This region is identified as the Reconnaissance Forest Zone and is currently considered noncommercial because of poor timber quality and accessibility.

The southern third of the province, called the Rural Forest Zone, is classified as the Grasslands Region. This area supports isolated stands or groves of species such as trembling aspen, white birch, Manitoba maple, some oak, and ash.

Gross merchantable volume of all species in the province is an estimated 905 million m³ (Table A-16). Roughly 60% of this volume is softwood, mainly spruce, pine, and fir, and the remaining 40% is hardwood such as aspen/poplar (32% of all species), birch, and other.

7.3.2 Current Status of Timber Supply (AAC)

Methods and Principal Assumptions

The current policy for Saskatchewan is to manage its forest land and timber to provide for a long-run sustained yield. For administrative purposes, the province's Commercial Zone is divided into "supply areas" (Figure A-7). For each supply area (including Forest Management License Agreements or FMLAs), a long-run sustained yield (LRSY) and harvest volume schedule are calculated.

LRSY is defined as "the estimated amount of merchantable fiber that could be harvested annually from the replacement forest produced from current and proposed forest management practises."

The harvest volume schedule is "the amount of wood that can be made available from specified areas of the existing forest on an annual or decade basis, without jeopardizing the long-run sustained yield for the forest as a whole." Estimated harvest volume schedule levels are lowered through the use of reduction factors that estimate the risk of loss of timber during a rotation period due to wildfire, waste, decay, and land withdrawal.

Current AAC

The current harvest volume schedule for Saskatchewan is an estimated 3.6 million m^3 of softwood and 3.0 million m^3 of hardwood (Table A-17).

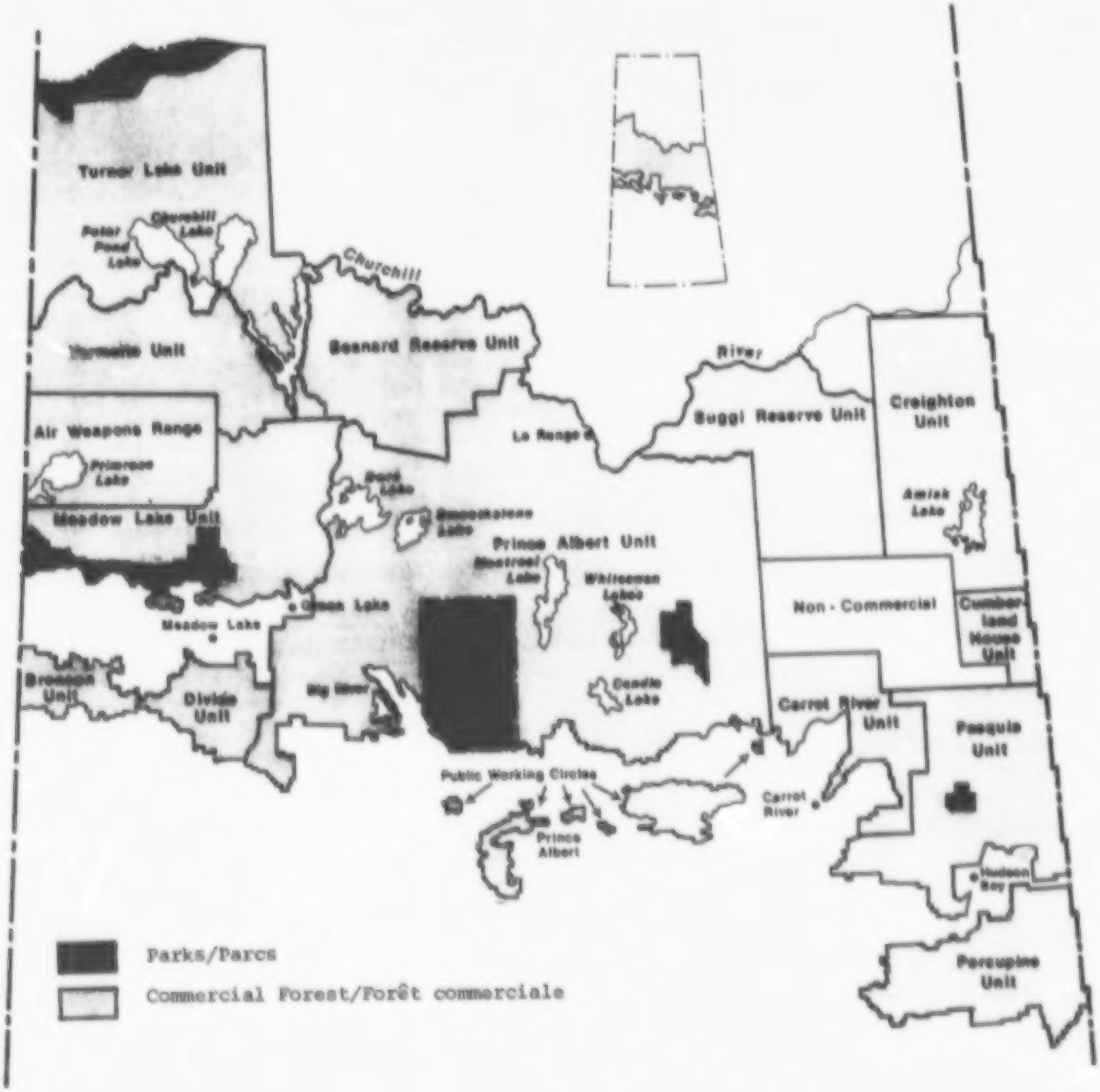
Turnor Lake Unit
Peter Pond Lake
Churchill Lake
Churchill
River
Vermette Unit
Besnard Reserve Unit
Air Weapons Range
Primrose Lake
La Ronge
Meadow Lake Unit
Dore Lake
Smoothstone Lake
Prince Albert Unit
Montreal Lake
Whiteswan Lakes
Green Lake
Meadow Lake
Bronson Unit
Divide Unit
Big River
Candle Lake
Suggi Reserve Unit
Creighton Unit
Amisk Lake
Non - Commercial
Cumberland House Unit
Carrot River Unit
Pasquia Unit
Public Working Circles
Carrot River
Prince Albert
Hudson Bay
Porcupine Unit
■ Parks/Parcs
□ Commercial Forest/Forêt commerciale

Figure A-7. Timber supply areas in the Commercial Zone in Saskatchewan (Forestry Branch, Saskatchewan Dept. of Parks and Renewable Resources).

Table A-17. Estimated AAC[a] for Saskatchewan.

Species Group	AAC
	1000 m^3
Softwood	3600
Hardwood	3000
Total	**6600**

[a] The AAC is the maximum allowable depletion or harvest.

7.3.3 AAC Compared with Harvest

Timber production in Saskatchewan averaged approximately 3.0 million m^3 from 1977 to 1986. Average production has been almost 2.7 million m^3 for softwoods (Figure A-8) and nearly 400 000 m^3 for hardwoods (Figure A-9). In 1985, slightly more than half of the softwood harvest was consumed by the pulp and paper industry, about one third went into lumber production, and the remainder went to plywood and other products. The majority of hardwoods (55%) was consumed in waferboard production while about 40% was used in pulp and paper.

If nontimber harvest (fire, insects, etc.) depletions are not taken into account, there is an apparent softwood surplus of about 1 million m^3. The surplus for hardwoods (excluding other depletions) is approximately 2.8 million m^3. As discussed earlier, for purposes of wood supply analysis, the province estimates a harvest volume schedule that excludes depletions other than

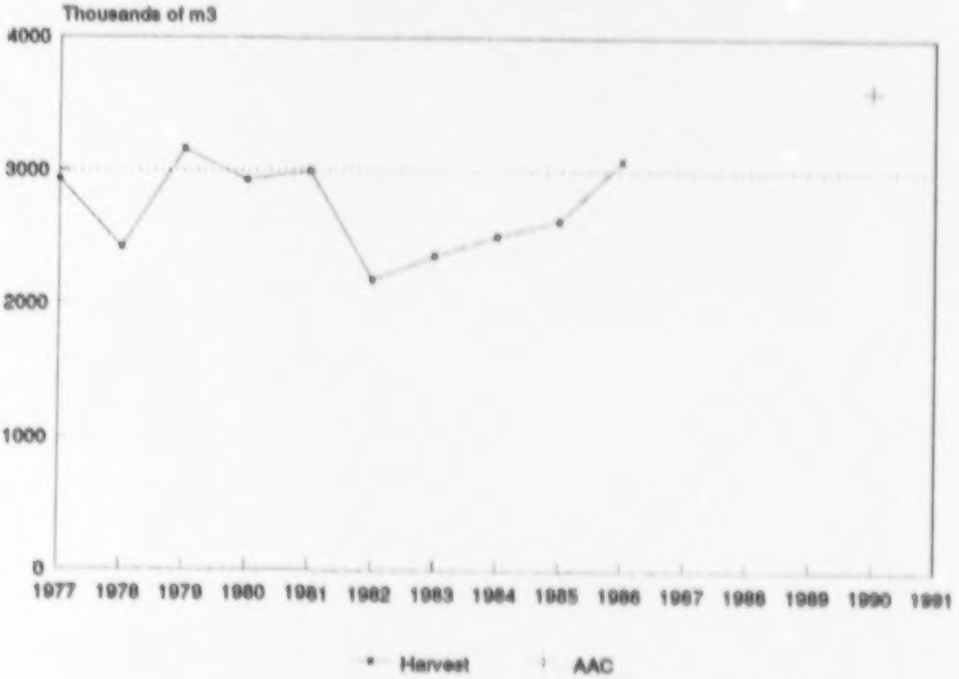

Figure A-8. Softwood timber harvest and estimated AAC in Saskatchewan.

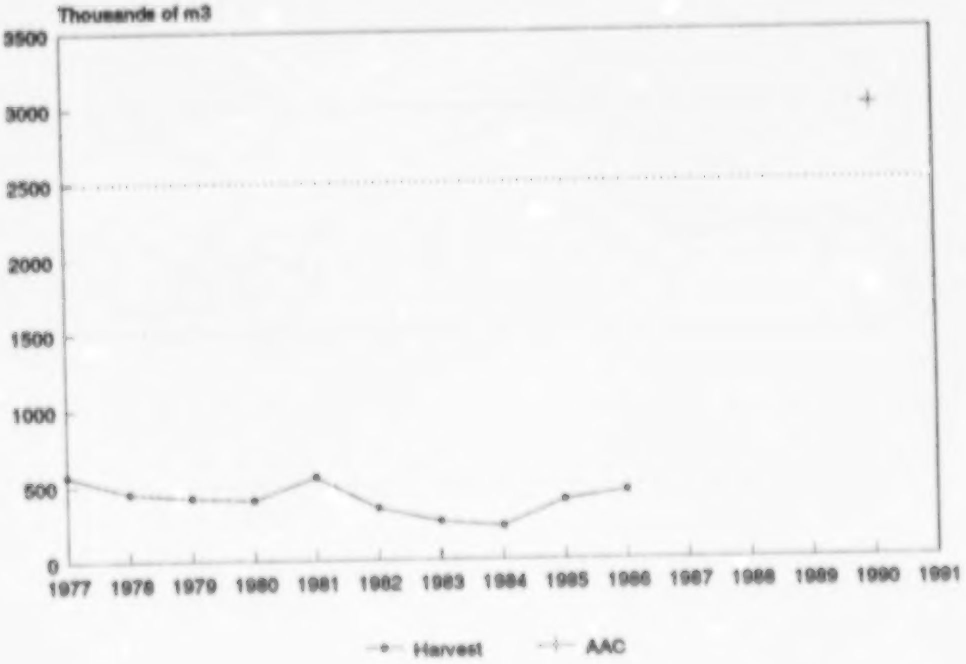

Figure A-9. Hardwood timber harvest and estimated AAC in Saskatchewan.

harvest. For softwood supply in 1985, these depletions totaled about 1.2 million m^3. By comparison, the volume harvested in 1985 was 2.1 million m^3 according to provincial government sources. This volume is about 0.5 million m^3 less than reported by Statistics Canada and shown in Figures A-8 and A-9. For hardwoods, depletions other than harvest for 1985 were estimated to be about the same as for softwoods (1.2 million m^3).

7.3.4 Long-Term Timber Supply Outlook

The long-term supply outlook of the provincial government basically reflects the timber availability as shown in Table A-17. This outlook assumes that the area in the Reconnaissance Zone will continue to be outside the economically available area. Analysis of softwood depletions other than harvest indicates that annual fire losses are about half the volume losses through harvest. For hardwoods, fire losses are only slightly less than annual harvests.

The long-term timber supply estimates are obviously sensitive to the level of fire protection and silviculture effort. As an example, the large proportion of stands in the immature age class offer great potential for increased yields through intensive management practices such as thinning or fertilization. Until better information on the sensitivity of timber supply to these factors is available, the consensus is that long-term timber supply will remain relatively stable.

7.4 Manitoba

7.4.1 The Physical Resource Stock and Its Characteristics

The Forest Land Base

Forest land in Manitoba covers an estimated 35 million ha or roughly 64% of the total land area. Of the 25 million ha (70%) of inventoried forest land area, 15 million ha is considered to be productive (Table A-18). The majority of this productive forest land is located in a band running through the central part of the province and extending down to the southeast corner (Figure A-10). To the north of the forest zone lies the tundra transition zone. In the south are prairie and agricultural lands.

The province is the largest forest land holder with approximately 13.5 million ha (90%) of inventoried productive area, followed by nonindustrial or private with about 1 million ha (7%), and the federal Crown with less than 400 000 ha.

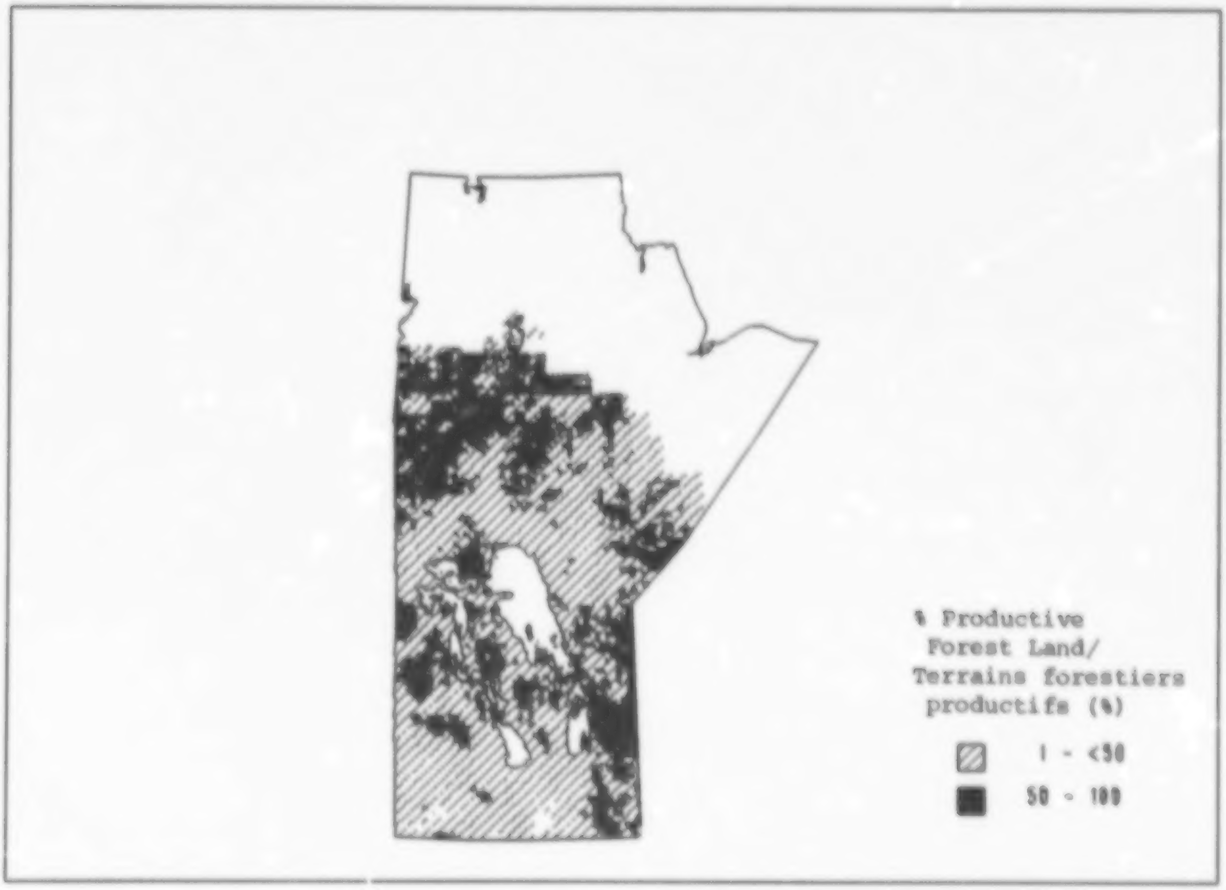

Figure A-10. Distribution of Manitoba's productive forest land area (Petawawa National Forestry Institute, Forestry Canada).

Table A-18. Area classification in Manitoba.

	Area	Percent of Total Land Area
	1 000 000 ha	
Total Land	**54.84**	**100.0**
Forest Land	34.92	63.7
Inventoried	25.12	45.8
Productive	14.92	27.2
Unproductive	10.20	18.6
Unspecified productivity	-	-
Noninventoried	9.80	17.9
Nonforest Land	19.92	36.3
Water	**10.16**	
Total Area	**65.00**	

Source: *Canada's Forest Inventory 1986* (Forestry Canada, 1989).

Table A-19. Maturity class of productive, stocked, and nonreserved forest land in Manitoba.

Class	Area	Percent of Stocked Area
	1 000 000 ha	
Nonstocked and unproven stocking	**1.57**	-
Stocked	**12.62**	**100.0**
Regeneration	1.21	9.6
Immature	8.96	71.0
Mature & overmature	2.46	19.5
Uneven-aged	-	-
Unclassified	-	-
Total	**14.19**	-

Source: *Canada's Forest Inventory 1986* (Forestry Canada, 1989).

Inventory data for productive, stocked, and nonreserved land indicate that the majority (9 million ha, or 71%) is covered with immature stands while only about 20% contains mature and overmature stands (Table A-19). In this regard, Manitoba's resource differs substantially from most other provinces (except for Saskatchewan) which have a considerably higher proportion of mature and overmature stands.

The Growing Stock

The Boreal Forest Region is the dominant forest ecotype in the province. This region is occupied primarily by black spruce. This species is found mainly on lowlands but also occurs on uplands. Jack pine is an important species occurring in pure stands on well-drained sites. White spruce is found on the southern portion of the Boreal Region on well-drained areas.

Table A-20. Inventory by species, all maturity classes in Manitoba.

Species	Volume	Percent of Total
	1 000 000 m^3	
Softwoods	**444**	**65.3**
Spruce	264	38.8
Pine	158	23.2
Fir	10	1.5
Other/unspecified	11	1.6
Hardwoods	**236**	**34.7**
Aspen/poplar	201	29.6
Birch	20	2.9
Other/unspecified	15	2.2
Total	**680**	**100.0**

Source: *Canada's Forest Inventory 1986* (Forestry Canada, 1989).

The Great Lakes–St. Lawrence Forest Region is located in the southeast part of the province. The original stands of red and white pine of this region have long since been replaced with jack pine following extensive logging and wild fires.

Gross merchantable volume on inventoried, stocked, productive, and nonreserved forest land is nearly 700 million m^3 (Table A-20). Of this volume, softwoods (primarily spruce and pine species) comprise 65% of the total with the remainder in hardwoods (mainly aspen and poplar).

7.4.2 Current Status of Timber Supply (AAC)

Methods and Principal Assumptions

Manitoba is divided into 10 forest sections for administrative purposes. Each section is further subdivided into several forest management units (FMUs). Allowable annual cut (AAC) is calculated by the Manitoba Forestry Branch through application of an area allotment method with volume checks. Separate AACs are determined for individual species working groups on provincial Crown land within each forest management unit. AACs are calculated for a utilization level of 12 cm dbh and higher, unless otherwise indicated.

1) The Theoretical AAC: The maximum annual harvest throughout the rotation period if all species with dbh greater than 10 cm are utilized.

2) The First Practical AAC: Includes only stands in the jack pine, black spruce, white spruce, and balsam fir working groups with volumes greater than or equal to 55 m^3/ha. Softwood stands with lower volumes and all hardwood stands are excluded.

3) The Second Practical AAC: Similar to the preceding AAC except that trembling aspen stands with volumes of at least 55 m^3/ha are included in the volume and area base.

4) The Third Practical AAC: All softwood stands with at least 25 m^3/ha and hardwood stands with at least 40 m^3/ha are included. This utilization level is considered the optimum achievable under realistically intense utilization of the forest base

For forest management planning purposes, AAC is determined by application of one of the three practical levels. In each FMU, the Forestry Branch analyzes the level of utilization that should be pursued by an operator. The determined utilization level will depend on market conditions, extraction costs, status, and ownership or location within the province. As an example, the Aspen-Parkland Section in the south central part of the province, is readily accessible. Therefore, the AAC for forest management planning purposes is calculated at the Third Practical AAC level, a high degree of utilization. On the other hand, the Hayes River Section is located in the northeastern part of the province where accessibility is limited. Therefore, AAC is determined at the second level (Second Practical AAC), a lower level of utilization. In addition to the preceding assumptions, in all but the theoretical AAC estimate, AACs are reduced by 12% to account for losses to insects and disease, road, railroad or powerline construction, wildfires, and the establishment of areas where cutting is restricted or prohibited.

Current Allowable Annual Cut (AAC)

The current allowable annual cut for Manitoba is an estimated 8.3 million m^3. Of this total, 5.9 million m^3 or 71% is softwood and 2.4 million m^3 is hardwood. The AAC of 8.3 million m^3 represents a physical volume available with some reductions for access, and utilization standards regarding size, and species. If areas such as those in the northern regions of the province are deducted because of limited accessibility, the AAC is reduced to 4.4 million m^3 or about 60% of the total (Table A-21).

Excluded from this calculation is the AAC on private forest land. Manitoba appears to have substantial wood volumes on private lands or "farm forests". Most of this volume is economically accessible. The total forest area on these private lands is about 1 million ha with a merchantable volume of approximately 56.7 million m^3. About 93% of this volume is hardwoods. Sustained timber supply from these lands is estimated at 540 000 m^3 (95% hardwoods).

7.4.3 AAC Compared with Harvest

The level of timber harvest in Manitoba has changed considerably over time. The estimated harvest in 1930 was reported to have been slightly more than 500 000 m^3. By 1950, the estimated harvest had increased to more than 1.0 million m^3. During the last 10 years for which data are readily available (1977-86), the average harvest including a small amount of fuelwood was about 1.8 million m^3. Approximately 1.6 million (90%) of this volume was softwood and the remainder hardwood (Figures A-11 and A-12).

Table A-21. Allowable annual cut of timber in Manitoba.

Species/Group	Total AAC[a]	Economically Accessible AAC[b]
	1000 m^3	
Softwoods	5918	2600
Hardwoods	2403	1807
Total	**8321**	**4407**

[a] Includes adjustments for stocking levels; size limitations; losses due to insects, disease, and fire; and some accessibility.
[b] Equal to the total AAC less AAC estimates for Churchill, Nelson River, and Hayes River forest sections.

Source: Manitoba Natural Resources, Forestry Branch, 1986.

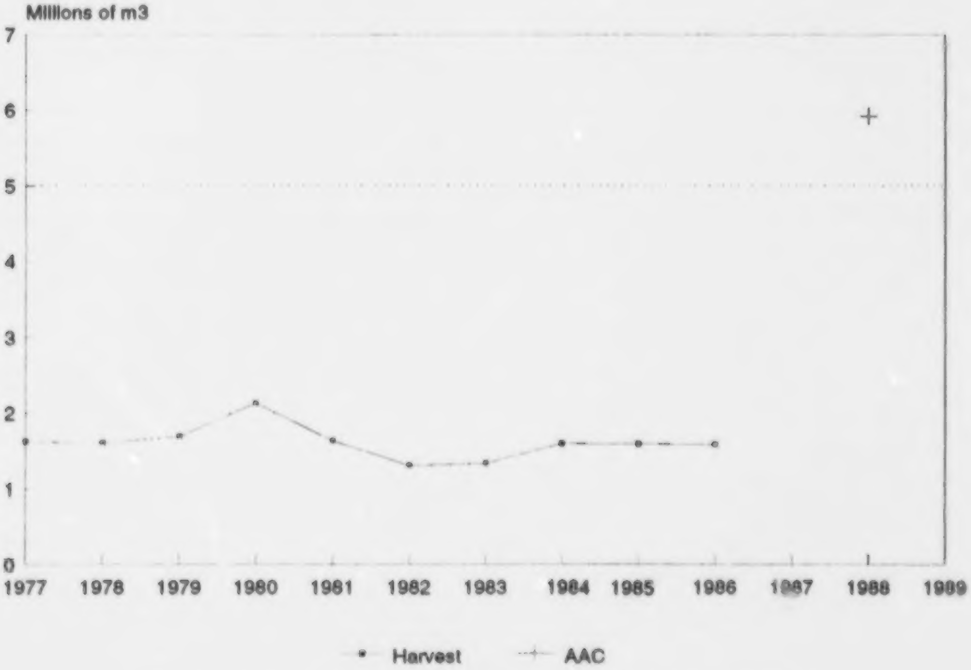

Figure A-11. Softwood timber harvest and AAC in Manitoba.

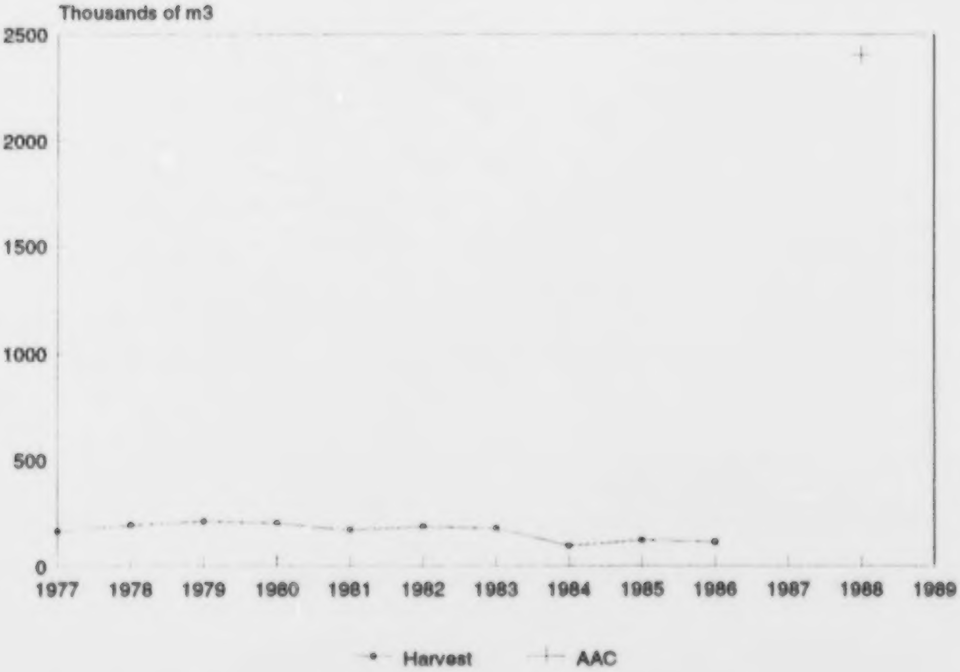

Figure A-12. Hardwood timber harvest and AAC in Manitoba.

During the past 5 years, approximately two thirds of this cut has been in the form of pulpwood, about 30% for sawlogs and the remainder for fuelwood. The AAC is substantially above historic and current harvest levels. Comparison of softwood cut with total AAC from 1981 to 1985 indicates that harvesting represents only about 27% of the total AAC and hardwoods only about 10%.

Comparing average harvest with economically accessible AAC, softwood harvest accounts for slightly less than 50% of the total available and hardwoods only about 11–12%. Indicated surpluses are not evenly distributed throughout the province. Comparison of total softwood AAC with harvest for the various forest regions shows that surpluses may vary from 15% in the Pineland region (southeast corner of the province), to 50% in the Saskatchewan region (west central), to 85% in the Interlake region (south central).

7.4.4 Long-Term Timber Supply Outlook

Schedule A of the 1984 Canada-Manitoba Forest Resource Development Agreement indicated that given current management practises, Manitoba's softwood AAC may have to be reduced considerably. The Department of Natural Resources has predicted that the available softwood supply (represented by AAC) in the currently harvested zone could be less than 1.0 million m^3 by 1995. This volume represents only half of the current annual demand for timber. "The implication for Manitoba's future forest industry is that a significant decline is imminent if new measures to enhance the magnitude and productivity of the forest base are not undertaken."

The AAC projection for Manitoba's softwood resource to the year 2000 is 2.6 million m^3. This projection is based on the total AAC estimate of 5.9 million m^3 less 3.6 million m^3 in remote areas (Churchill, Nelson River, Hayes River, and portions of other regions) plus 0.3 million m^3 considered to become accessible. Adjusted AAC for hardwoods to the year 2000 is estimated to be 1.6 million m^3.

These figures are compared with estimates of potential demand to the year 2000. For example, using the **peak** softwood harvest level from 1981 to 1985 (2.1 million m^3) and 3% annual growth, timber demand would equal AAC (2.6 million m^3) between 1990 and 1995. Using the more conservative **average** harvest from 1981 to 1985 of 1.45 million m^3 and a 2.5% annual increase in demand, wood requirements by the year 2000 would be only 2.1 million m^3.

This outlook suggests a possible surplus in roundwood supply. However, this situation may change due to the recent agreement with Repap Manitoba Inc. and an associated increase in wood requirements. The agreement means that starting in the mid-1990s, an additional 1.75 million m^3 of softwood and 0.84 million m^3 of hardwood will be required for industrial consumption. Softwood supplies in the south may be more constrained in the future; however, opportunities for tapping the underutilized northern resource exist assuming improved access is developed.

Sensitivity of Forecasts to Assumptions

Several other factors may have an impact on the long-term supply situation. Pressures on the resource include potential land alienation for agriculture and recreation uses. Many of Manitoba's major processing facilities are located adjacent to good quality farm land and prime recreational areas. Wildfire losses are substantial. From 1976 to 1986, annual losses of productive forest averaged 90 000 ha and 4.7 million m^3, about two and one half times the annual harvest. Reducing fire losses would have a significant impact on future timber supplies.

Long-range forecasts would be influenced positively through increased silvicultural activity, making more land accessible, and including private lands in the AAC. The province has substantially increased forest management activities. For example, in 1981 about 3.4 million trees were planted; this figure increased to 9.0 million in 1985 and by 1989 the number is expected to be 20 million. Given the predominance of forests in the immature age class, stand tending treatments could substantially expand future timber supply from existing forests.

As indicated earlier, private lands currently have the potential of contributing slightly more than 500 000 m^3 per year to the hardwood AAC. As well, recent developments in increased utilization of hardwoods could have a major impact on softwood availability since much of this material occurs in mixedwood stands.

7.5 Ontario

7.5.1 The Physical Resource Stock and Its Characteristics

The Forest Land Base

Ontario's land area totals almost 90 million ha, of which approximately 80 million ha (90%) are forested. Much of the northern part of the province is not covered by the current forest inventory. Coverage does not extend beyond latitude 50.00 N in northeastern Ontario and 52.00 N in northwestern Ontario. Therefore, only about half of the forest land area is inventoried (Table A-22, Figure A-13).

Approximately 38 million ha (80%) of the inventoried forest area is classified as productive. In terms of total productive area, Ontario ranks third behind Quebec and British Columbia and comprises 16% of Canada's productive land. The majority of this productive forest is estimated to be stocked and nonreserved.

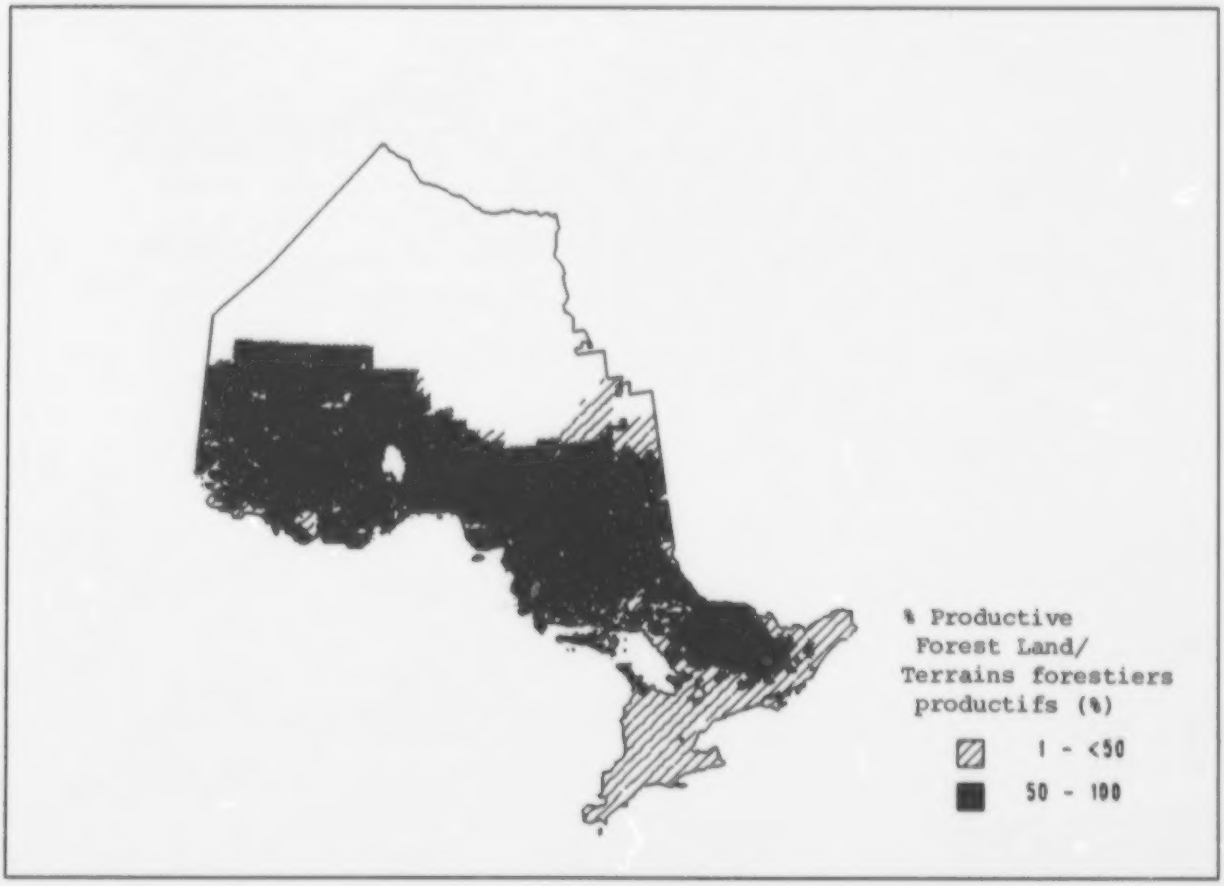

Figure A-13. Distribution of Ontario's productive forest land area (Petawawa National Forestry Institute, Forestry Canada).

Table A-22. Area classification in Ontario.

	Area	Percent of Total Land Area
	1 000 000 ha	
Total Land	**89.12**	**100.0**
Forest Land	80.70	90.6
Inventoried	46.60	52.3
Productive	38.29	43.0
Unproductive	8.32	9.3
Unspecified productivity	–	–
Noninventoried	34.10	38.3
Nonforest Land	8.42	9.4
Water	**17.74**	–
Total Area	**108.86**	–

Source: *Canada's Forest Inventory 1986* (Forestry Canada, 1989).

Table A-23. Maturity class of productive, stocked, and nonreserved forest land in Ontario.[a]

Class	Area	Percent of Stocked Area
	1 000 000 ha	
Nonstocked and unproven stocking	**4.08**	–
Stocked	**32.69**	**100.00**
Regeneration	1.18	3.6
Immature	12.33	37.7
Mature & overmature	19.17	58.6
Uneven-aged	0.01	0.0
Unclassified	0.01	0.0
Total	**36.77**	–

[a] Note that Ontario does not use these maturity class definitions. Instead, the province uses 20-year age classes without specific headings such as "uneven-aged."

Source: *Canada's Forest Inventory 1986* (Forestry Canada, 1989).

The majority (84.5%) of productive land is held under provincial Crown ownership (32.34 million ha), followed by nonindustrial private with 12.7% (4.87 million ha), industrial with 2.1% (790 000 ha), and the remainder with the federal Crown and others.

The age-class distribution of the forest is similar to most other provinces in that a high proportion of area (58.6%) contains mature or overmature timber. In addition, 38% of the area contains material classified as immature (Table A-23).

Table A-24. Gross merchantable volumes by species, all maturity classes in Ontario.

Species	Volume	Percent of Total
	1 000 000 m^3	
Softwoods	**2 205**	**62.5**
Spruce	1 335	37.8
Pine	578	16.4
Fir	188	5.3
Other/unspecified	104	2.9
Hardwoods	**1 325**	**37.5**
Aspen/poplar	685	19.4
Birch	361	10.2
Maple	200	5.7
Other/unspecified	79	2.2
Total	**3 529**	**100.0**

Source: *Canada's Forest Inventory 1986* (Forestry Canada, 1989).

The Growing Stock

Ontario is characterized by three principal forest regions (Rowe, 1972): (1) the Deciduous Region, (2) the Great Lakes-St. Lawrence Region, and (3) the Boreal Region. Ontario is the only Canadian province containing the Deciduous Region. This area is located in southwestern Ontario, along the Great Lakes, and is represented by species such as sugar maple, beech, basswood, oaks, black walnut, and hickory. Softwood species such as white pine, eastern red cedar, and hemlock are also found in this region.

The Great Lakes-St. Lawrence Region is located just north of the Deciduous Region. This region represents a transition zone between the Deciduous and Boreal regions and includes deciduous species such as sugar maple, red maple, yellow birch, basswood, white birch, and trembling aspen. Common coniferous species include black and white spruce, jack pine, red pine, and white pine. The Boreal Region is the largest in the province. This region is characterized primarily by softwoods such as black and white spruce, balsam fir, jack pine, and limited amounts of hardwoods such as white birch and aspen. To the north and east of the Boreal Region emerges an increasingly barren area with only scattered patches of small-sized black spruce and tamarack.

Table A-24 shows Ontario's gross merchantable volume by principal species for the inventoried, stocked, productive, and nonreserved forest land. Almost two thirds of the volume is in softwood species, mainly black and white spruce with a substantial volume of pine. Hardwoods such as aspen, poplar, and birch make up the remainder.

7.5.2 Current Status of Timber Supply (AAC)

Methods and Principal Assumptions

For administrative purposes of the Ontario Ministry of Natural Resources (OMNR), the province is divided into eight regions (Figure A-14).

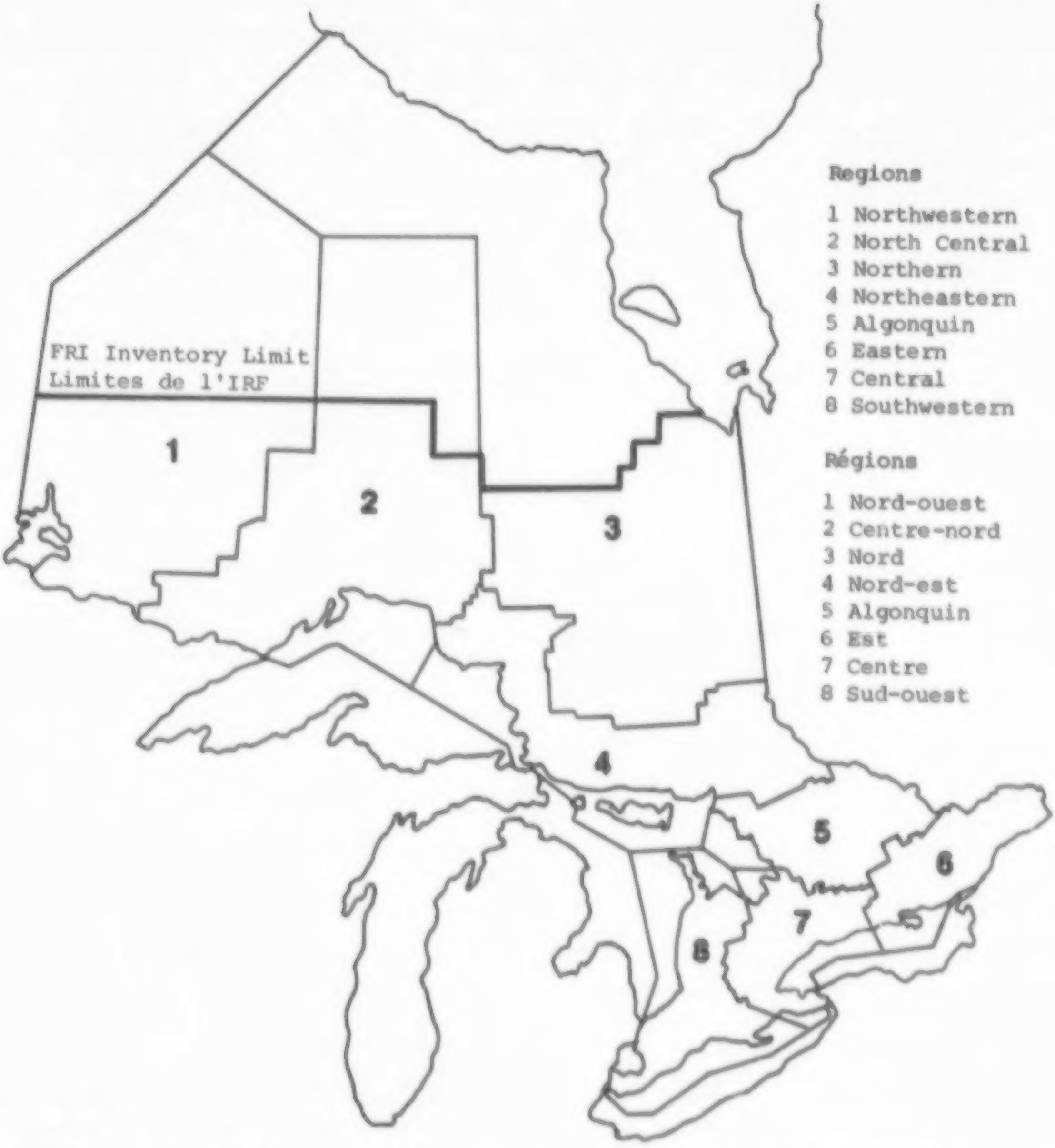
FRI Inventory Limit
Limites de l'IRF
1
2
3
4
5
6
7
8
Regions
1 Northwestern
2 North Central
3 Northern
4 Northeastern
5 Algonquin
6 Eastern
7 Central
8 Southwestern
Régions
1 Nord-ouest
2 Centre-nord
3 Nord
4 Nord-est
5 Algonquin
6 Est
7 Centre
8 Sud-ouest

Figure A-14. OMNR administrative regions and northern limit of forest resources inventory coverage (Smyth, 1988).

The province is also subdivided into forest management units (FMUs) (Figure A-15). As of late 1989, 93 active FMUs existed throughout the province. In addition, six inactive and unregulated units exist across northern Ontario. The number of FMUs has gradually declined from 106 in 1987 (Tworzyanski, 1987) as units are combined for the next planning period. FMUs are

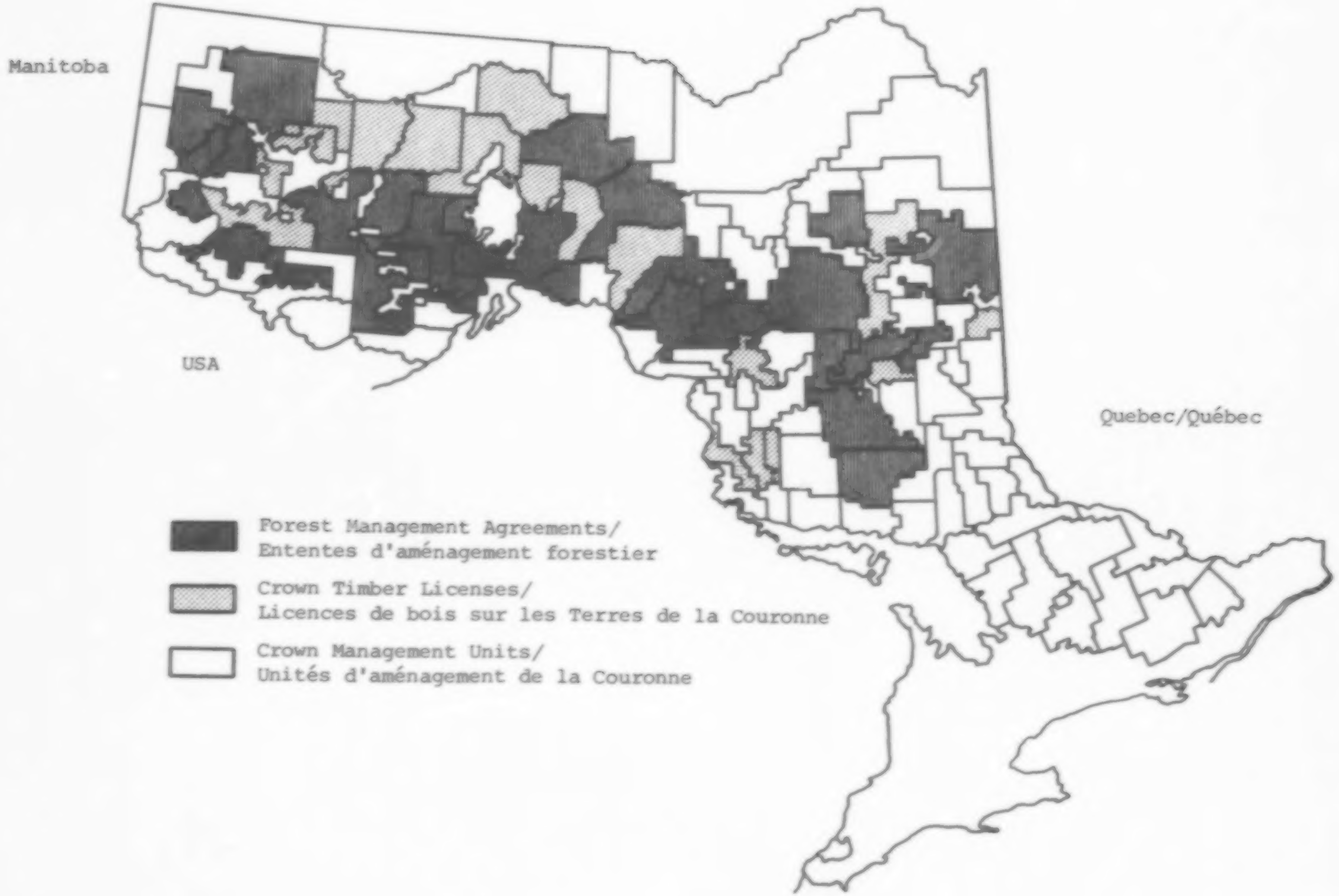
Manitoba
USA
Quebec/Québec
Forest Management Agreements/
Ententes d'aménagement forestier
Crown Timber Licenses/
Licences de bois sur les Terres de la Couronne
Crown Management Units/
Unités d'aménagement de la Couronne

Figure A-15. Forest management units in Ontario (Smyth, 1988).

categorized into one of three classes.[1] These are (1) Crown management units which the ministry manages and controls, (2) Forest Management Agreements (FMAs) which are a license subdivision and are managed by companies, and (3) company management units in which planning and management is shared by both the ministry and companies. Presently, the 93 FMUs consist of 51 Crown management units, 28 FMAs, and 14 company management units.

The 1972 Forest Production Policy set a provincial production target of 25.8 million m^3 of industrial roundwood on an annual basis by the year 2020. According to Baskerville (1986), the province's 1986 Timber Management Planning Manual states that "The objective of the forest management program on Crown land in Ontario is to provide for an optimum continuous contribution to the economy by the forest-based industries consistent with sound environmental practices and to provide for other uses of the forest." Further, "The purpose of timber management planning is to organize the activities of harvest, renewal, and maintenance on the forest to ensure the availability of forest products from an area consistent with this objective."

In his review of management plans for selected Crown management units and FMAs, Baskerville found that principal objectives for management included maintenance of an even-flow of timber, provision of industry requirements, and attainment of a balanced age-class structure.

In 1986, OMNR changed the name of its regulatory measure of sustained yield management from annual allowable cut (AAC) to maximum allowable depletion (MAD). The MAD is calculated on an area basis with the objective of sustained yield management (Tworzyanski, 1987). The MAD is an estimate of maximum timber depletions on a given forest land base for an initial 5 years. Timber depletions account for losses from harvesting, fire, insects, disease, and the reallocation of forest land area to other uses to fulfill the objectives of management (OMNR, 1986). The terminology was changed because the former definition of AAC implied that the calculated amount of allowable depletion was available entirely for timber harvest.

The OMNR uses the Ontario Wood Supply and Forest Productivity simulation model (OWOSFOP) to calculate MAD on a management unit basis. The OWOSFOP model provides estimates of gross total volume yields of allowable cut areas based on empirical yields derived from the aggregation of actual working group site-class distributions on the forest in question (Tworzyanski, 1987). The Forest Resources Inventory is used in conjunction with Plonski's Yield Tables as the source of empirical volumes. The model uses several assumptions in calculating gross total volume yields regarding:

- free to grow period
- rotation period
- rehabilitation rate of not sufficiently restocked lands
- choice of average age, normal age, and specified acceleration factor
- level of harvest other than full MAD
- harvest of specified age classes or "oldest first"
- age of death
- land base losses due to roads and landings
- regeneration success.

The gross total volume estimates by species are distilled down to net merchantable volumes by deducting average losses from cull, tops, and stumps for all age classes.

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[1] A comprehensive review of the administration and management of forest land in the province is provided in *An Audit of Management of the Crown Forests of Ontario* (Baskerville, 1986).

Table A-25. Maximum allowable depletion, all forest management units in Ontario (1990/91).

Species Type	MAD
	1 000 000 m^3
Softwood	28.4
Hardwood	16.9
Total	45.3

Source: J.F. Goodman, personal communication, 1989.

MAD estimates for second, third, and fourth periods of 5 years are determined from the previous cutting rates plus assumptions regarding land withdrawals/accruals, and regeneration rates.

Current MAD

As indicated in the foregoing, the process of timber supply estimation used in Ontario varies considerably from methods used in other provinces. An AAC is not determined directly but is calculated indirectly by area available and volume on that area. All active management units currently have MAD estimates.

The OMNR provided MAD estimates for all active management units on Crown land for 1990/91 (Table A-25). The land base used for the MAD estimates is 515 000 ha which comprises 315 000 ha of softwoods and 200 000 ha of hardwoods. The MAD estimates include all predicted harvest, surplus, and inoperable/bypass volumes, but not volumes in reserves (areas restricted from harvest). The estimates also include a 10% deduction to account for unknown amounts of inoperable/bypass area which is not calculated in surveys where the inoperable/bypass is less than a contiguous 8 ha.

7.5.3 MAD Compared with Harvest

The scaled roundwood harvest from Crown lands (the area used in the previous MAD estimates) was approximately 20.6 million m^3 in 1987/88. Therefore, commercial timber harvesting accounts for less than half of the potential volume represented by the MAD estimate. The harvest consists of 16.9 million m^3 and 3.7 million m^3 of softwoods and hardwoods, respectively. This indicates that the softwood surplus (relative to harvest) is approximately 11.5 million m^3 while the hardwood surplus is 13.5 million m^3. Figures A-16 and A-17 compare total production (including private lands), with the MAD. In 1987/88 total harvest was about 26 million m^3 of which 6.2 million m^3 came from private lands.

The MAD is not an AAC estimate, but rather a maximum depletion from several sources including timber harvesting. Thus, the difference between the MAD and timber harvest should not be viewed as a surplus available for harvesting only. A portion of this difference could be lost to several other natural and human causes. It also applies only to Crown lands.

Results of a survey of management units (80 units reporting, representing 82% of productive forest land with active management plans) showed that for 1980/81 to 1984/85, annual harvest depletion for softwood species was only about 50% of the allowable depletion (allowable volume for these units was 21.6 million m^3). For hardwoods, average harvest depletion for the period was 19% of the total (allowable volume was 12.4 million m^3).

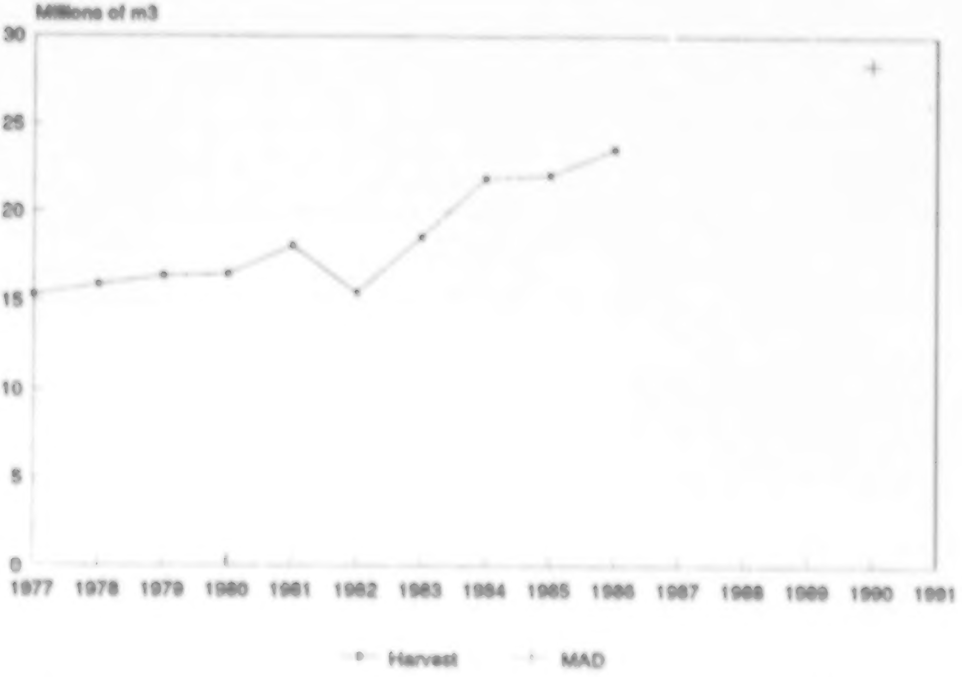


Figure A-16. Softwood timber harvest and maximum allowable depletion (MAD) in Ontario.

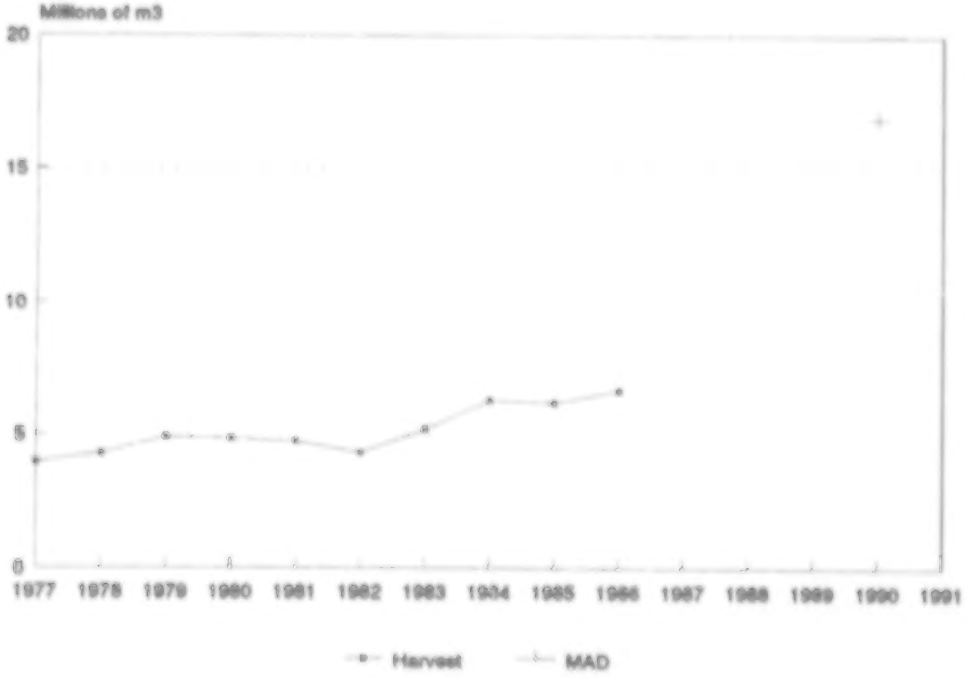


Figure A-17. Hardwood timber harvest and maximum allowable depletion (MAD) in Ontario.

7.5.4 Long-Term Timber Supply Outlook

Generally, since Ontario's forest stock is heavily skewed to the mature and overmature age classes, future timber availability is forecast to decline until normal regulation occurs in about 40 years.

Baskerville (1986) suggests that the current MAD calculation permits an acceleration of harvest area where"...the average age of all the stands of a working group in the forest exceeds one-half the rotation age, the allowable depletion is increased in proportion to the difference." Further, "The use of acceleration increases current harvest levels both in area depleted, and in volume generated by that area depletion, over time. This is the principle cause of a decline in harvest volume over time forecast for the Units examined."

7.6 Quebec

7.6.1 The Physical Resource Stock and Its Characteristics

The Forest Land Base

Quebec has the largest inventoried productive forest land base of any province in Canada with 54.8 million ha or 22.5% of the national total (Table A-26 and Figure A-18). Almost 50 million ha (91%) of this area is considered to be stocked and nonreserved (Table A-27).

Ownership of inventoried productive land is vested primarily with the provincial Crown with almost 48 million ha (88%). Private ownership amounts to 6.6 million ha (12%), and the remainder is federal Crown. Approximately 11% of the productive forest land is held in small private woodlots (less than 800 ha) by an estimated 125 000 owners. Most of these private woodlots are located in southern Quebec along the St. Lawrence River.

The forest land area of Quebec is similar to most others in Eastern Canada regarding distribution of growing stock by maturity class. Almost 46% of the area of productive, stocked, and nonreserved land is stocked with trees considered to be mature and overmature (Table A-27). As in neighboring New Brunswick, this age-class structure is due largely to past spruce budworm outbreaks and harvesting practises.

The Growing Stock

Quebec's forests encompass two principal forest regions, and three distinct areas of productivity. To the far north (above 52° latitude) lies the forest and barren sections of the Boreal Region. This area, classified as Taiga by the Quebec Ministry of Forests (MFO), is sparsely wooded and has no commercial forestry potential. To the immediate south, extending down to about 48° latitude, is the southern portion of the Boreal Region. This area is primarily occupied by

Table A-26. Area classification in Quebec.

	Area	Percent of Total Land Area
	1 000 000 ha	
Total Land	**135.68**	**100.0**
Forest Land	94.00	69.3
Inventoried	82.49	60.8
Productive	54.79	40.4
Unproductive	27.70	20.4
Unspecified productivity	–	–
Noninventoried	11.50	8.5
Nonforest Land	41.68	30.7
Water	**18.39**	–
Total Area	**154.07**	–

Source: *Canada's Forest Inventory 1986* (Forestry Canada, 1989).

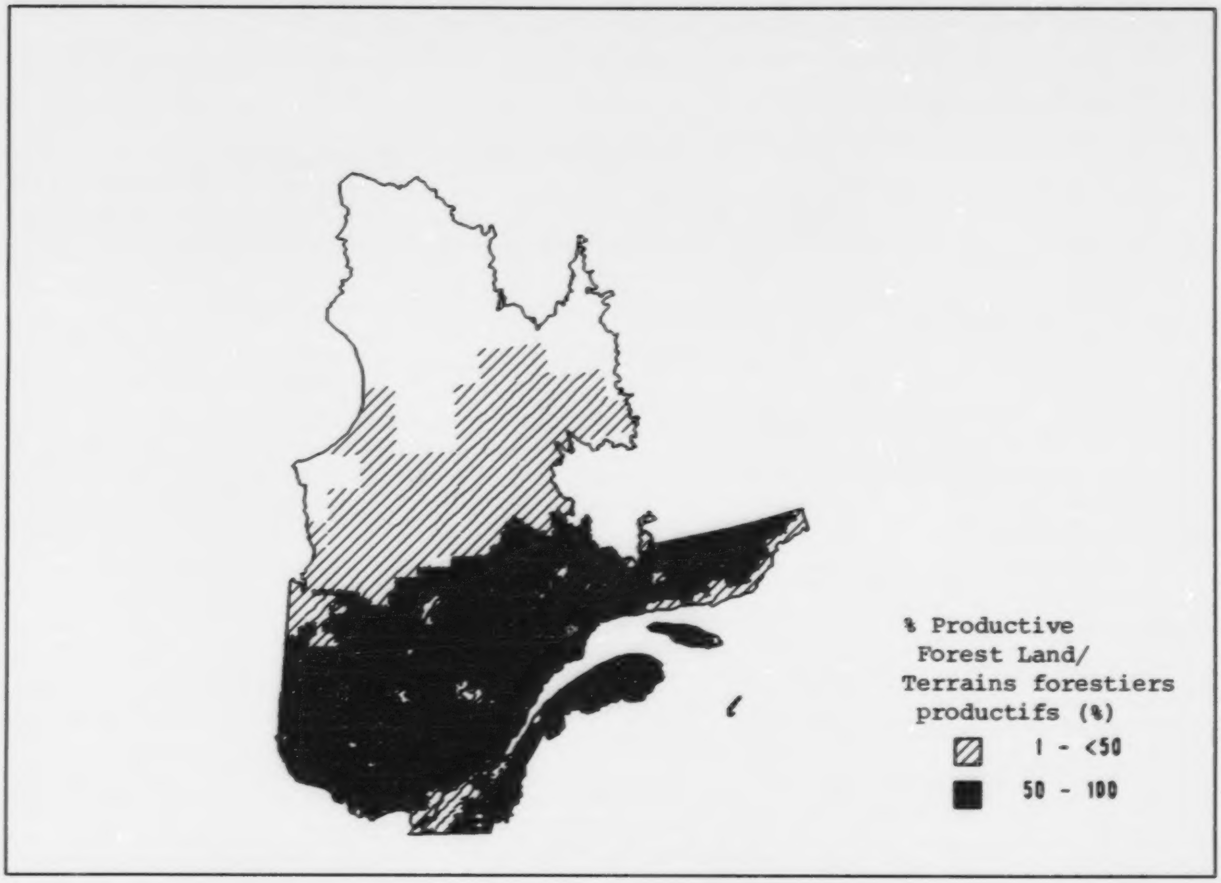

% Productive Forest Land/
Terrains forestiers productifs (%)
▨ 1 - <50
■ 50 - 100

Figure A-18. Distribution of productive forest land in Quebec (Petawawa National Forestry Institute, Forestry Canada).

Table A-27. Maturity class of productive, stocked, and nonreserved forest land in Quebec.

Class	Area	Percent of Stocked Area
	1 000 000 ha	
Nonstocked and unproven stocking	**4.83**	-
Stocked	**49.57**	**100.00**
Regeneration	5.10	10.3
Immature	9.20	18.6
Mature & Overmature	22.67	45.7
Uneven-aged	0.15	0.3
Unclassified	12.45	25.1
Total	**54.40**	-

Source: *Canada's Forest Inventory 1986* (Forestry Canada, 1989).

Table A-28. Inventory by species, all maturity classes in Quebec.

Species	Volume	Percent of Total
	1 000 000 m³	
Softwoods	**3 021**	**71.5**
Spruce	1 774	42.0
Pine	246	5.8
Fir	884	20.9
Other/unspecified	117	2.8
Hardwoods	**1 205**	**28.5**
Aspen/poplar	295	7.0
Birch	529	12.5
Maple	297	7.0
Other/unspecified	84	2.0
Total	**4 226**	**100.0**

Source: *Canada's Forest Inventory 1986* (Forestry Canada, 1989).

spruces, balsam fir, jack pine, white birch, and trembling aspen. Farther to the south, along the St. Lawrence River, lies the Great Lakes–St. Lawrence Region, which is characterized by a variety of species such as red and white pines, hemlock, yellow birch, maple, and oak. The forest area situated below the latitude of 52° is considered productive by MFO.

The gross merchantable volume of softwood species such as spruce, balsam fir, and pine is estimated to be approximately 3.0 billion m³ or 71.5% of the total for the province. Volume in hardwood species such as birch, maple, aspen and poplar is estimated to be 1.2 billion m³, or 28.5% of the total (Table A-28).

7.6.2 Current Status of Timber Supply

Methods and Principal Assumptions

On April 1, 1987, the province of Quebec enacted new forest management legislation and policies. These changes revoked the previous long-term leases and concessions and replaced these with volume agreements for a specified area (referred to as CAAF — contrats d'approvisionnement et d'aménagement forestier, supply and management contracts).

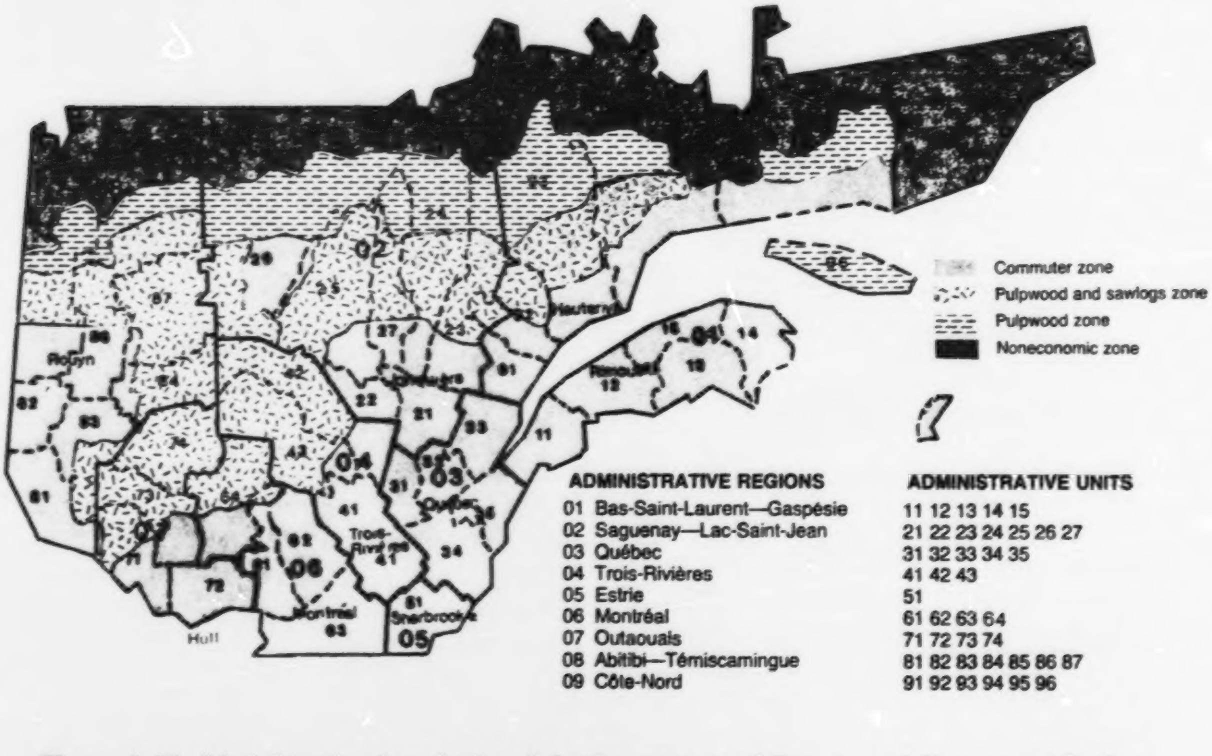
In these volume agreements, the contract is for 25 years with a 5-year renewal term. In addition, provisions in the act stipulate that private lands will constitute the basic supply with the residual coming from the Crown forests. Initially, the licensee is financially responsible for all silvicultural activities pertaining to his CAAF except for seedlings for reforestation, which the government provides. The government also reimburses licensees for the forest management works carried out by reducing stumpage charges accordingly.

A few years preceding the CAAF negotiations, the provincial government established forestry reference data which constituted the basis of a document produced in conjunction with company associations. This document set out the responsibilities of each participant in the negotiations and specified the criteria by which the Crown established the sustained yield targets for each forest area eligible for leasing. Company negotiations were completed late in 1990. The AACs and sustained yield targets that resulted from the negotiation process will be determined later in 1991.

In determining the AAC, the province is delineated into four zones and nine administrative regions (Figure A-19). It is noteworthy that in 1991, the province has reorganized its territory in 16 administrative regions. The four zones include:

1) the commuter zone which is the southernmost area
2) immediately to the north is the sawlog and pulpwood zone
3) farther north is the pulpwood zone, and
4) to the extreme north is the noncommercial zone.

The latter two zones are considered uneconomical to harvest now and are therefore largely excluded from the AAC calculations. In addition to these land base deletions, a further 11% is removed because of excessive slope (that is, greater than 30–50%), green belts, reserves, and other territories. The CAAF negotiations include some portions of zone 3 and exclude unproductive areas in zone 2. Therefore, we can anticipate that the net effect should not significantly change the province's total productive forest area compared with calculations made before the new forest legislation and the CAAF. The AAC, then, would be calculated from a net land base of about 25.5 million ha, or approximately half of the inventoried productive forest land area in 1986.



ADMINISTRATIVE REGIONS	ADMINISTRATIVE UNITS
01 Bas-Saint-Laurent—Gaspésie	11 12 13 14 15
02 Saguenay—Lac-Saint-Jean	21 22 23 24 25 26 27
03 Québec	31 32 33 34 35
04 Trois-Rivières	41 42 43
05 Estrie	51
06 Montréal	61 62 63 64
07 Outaouais	71 72 73 74
08 Abitibi—Témiscamingue	81 82 83 84 85 86 87
09 Côte-Nord	91 92 93 94 95 96

Figure A-19. Administrative boundaries of the Department of Energy and Resources (Quebec Department of Energy and Resources, 1987). (Note: This map does not reflect recent changes in administrative boundaries.)

Table A-29. AAC in Quebec for principal species groups and landowners.

Species	Crown[a]	Private[b]	Total
		1 000 000 m^3	
Softwoods	**31.0**	**4.7**	**35.7**
Spruce, fir, jack pine	29.3	3.6	32.9
Other softwoods	1.7	1.1	2.8
Hardwoods	**11.2**	**7.8**	**19.0**
White birch	4.0	–	–
Yellow birch	1.4	–	–
Maple	2.0	–	–
Poplar & other	3.8	–	–
Total for all species	**42.2**	**12.5**	**54.7**

[a] The AAC calculations reflect the new forest legislation and the new CAAF territories. A portion of this AAC remains uncommitted and forms a reserve for future CAAF requests. For example, total softwoods commitments are 26.9 million m^3 compared with an AAC of 31 million m^3; for hardwoods, commitments total only 4.1 million m^3 compared with the 11.2 million m^3 AAC.

[b] Estimated using Von Mantel formula.

Source: Quebec Department of Energy and Resources, 1990. Rapport sur l'état des forêts publiques québécoises (amended 1991).

Further reductions are made in timber availability to account for several factors:

1) stocking: balsam fir, spruce, and pine volume must reach at least 50 m^3/ha at maturity in predominantly softwood areas;
2) spruce budworm losses: infestations of the past have been accounted for but not future impacts;
3) fire: losses are not considered until they occur;
4) accessibility: all areas in the 25.5-million ha zone are assumed to be accessible.

The AAC for principal species groups by management unit, and region are then calculated. Actual tracking of inventory and change over time and determination of AAC is done with the SYLVA model — an allocation and simulation model that keeps account of area, volumes, etc.

Current AAC

Estimated current AAC (February 1991) for the province of Quebec is slightly more than 35.5 million m^3 of softwood and 19 million m^3 of hardwood (Table A-29). The AAC for Crown lands is estimated to be about 42 million m^3 or 77% of the total while the remaining 12.5 million m^3 is on private lands, the majority of which are small woodlots.

7.6.3 AAC Compared with Harvest

Average harvest volume (including fuelwood) for Quebec during the 10 years from 1977 to 1986 was about 34.2 million m^3. Approximately 30.6 million m^3 or 86.5% was softwood. The majority (94.0%) of total harvest has been for industrial use. A little more than half of the harvest volume (55.8%) was in the form of logs and bolts, apparently for lumber production. The remainder of the harvest was pulpwood.

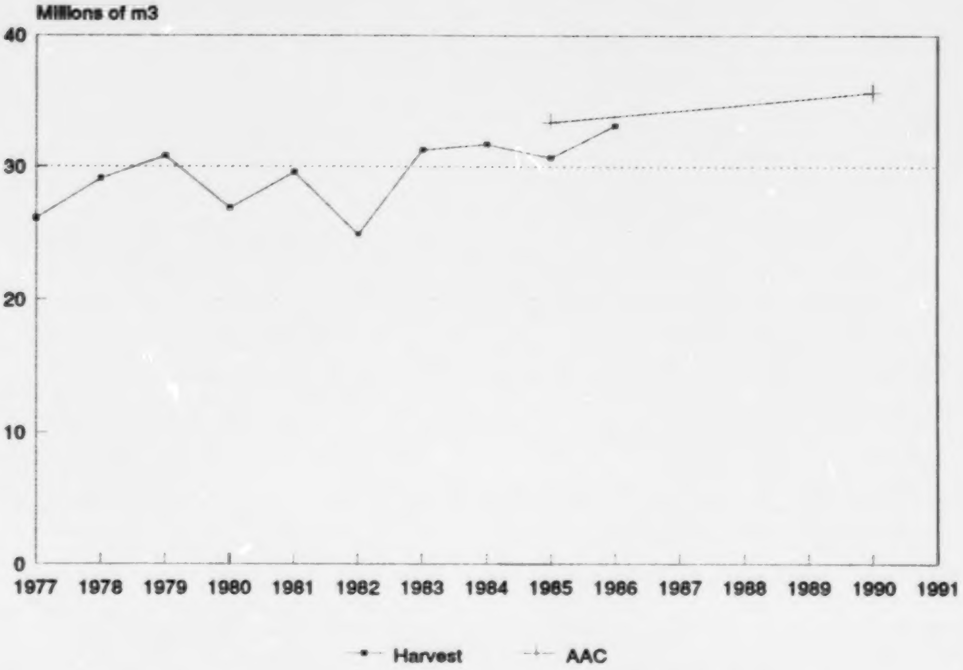


Figure A-20. Softwood timber harvest and AAC in Quebec.

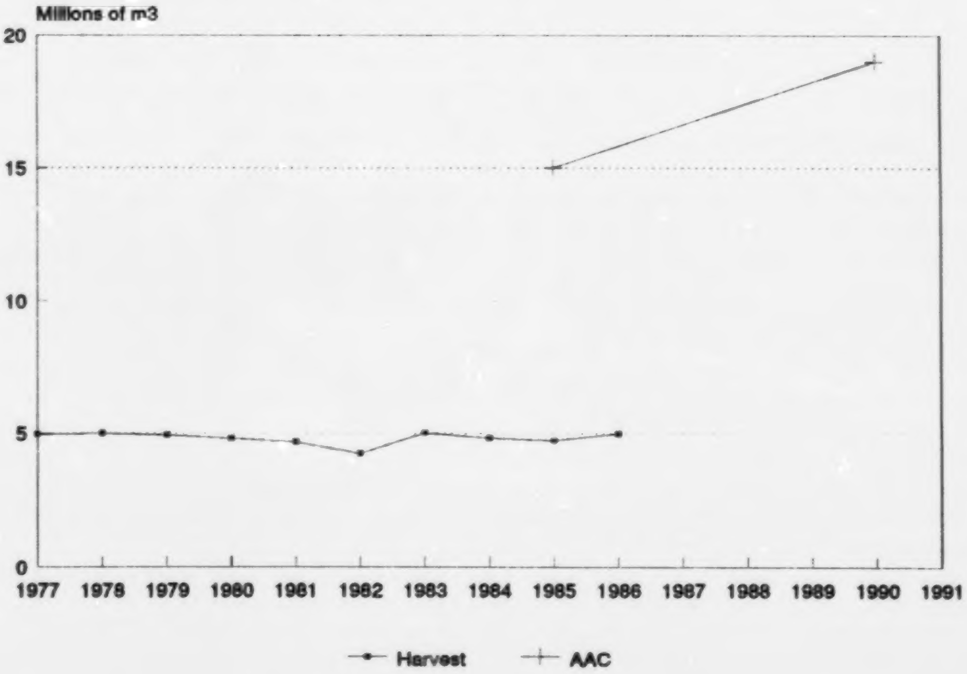


Figure A-21. Hardwood timber harvest and AAC in Quebec.

Harvest from private lands (including fuelwood) is estimated to be approximately 7.5 million m^3 or roughly one quarter of the total harvest. The proportion of the harvest from private lands appears to be on a slight upward trend.

Figure A-20 shows softwood harvest from 1977 to 1986 compared with the latest estimate of AAC from both public and private forests. The average softwood harvest from 1983 to 1985 was very close to the softwood AAC. In the preceding 4 years, however, a small surplus existed in the AAC relative to softwood harvest.

The hardwood picture is considerably different. Average hardwood harvest from 1977 to 1986 was about 4.8 million m^3, including fuelwood. This harvest level has remained relatively steady during the 10 years. The estimated AAC of hardwoods is 19 million m^3 or almost 4 times the harvest (Figure A-21).

7.6.4 Long-Term Timber Supply Outlook

Background statements in the Canada-Quebec Forest Development Subsidiary Agreement, 1985–1990, indicate that the medium-term outlook for softwood timber supply would not be good if appropriate measures were not taken. The principal problem cited is losses to the spruce budworm. The volume lost due to the recent budworm epidemic is an estimated 148 million m^3. This volume is equal to the total softwood volume processed by the sawmilling and pulp and paper industries in the last 5 years.

Two other problems contribute to the timber supply outlook. First, approximately 46% of Quebec's softwood forests are mature or overmature. Net merchantable volume in many of these stands is declining. Second, the substantial reserves of timber in the north are currently uneconomic to harvest. Much of this volume is on low productivity sites, transportation is expensive, and labor availability may be a problem.

Sensitivity of Forecasts to Assumptions

To prepare for the upcoming negotiation of the CAAF, the province made several AAC simulation runs in 1987, using the forestry data contained in the decennial inventory of the time. The results of this exercise, summarized here, provide some indication of the sensitivity of softwood AAC to various management options. Figure A-22 presents four different scenarios. The simulations cover a 120-year period and represent the following conditions:

K = 1, the sustained yield allowable cut assuming a long rotation (extensive forest management).

K = 2, the allowable cut assuming a short rotation and no reforestation (extensive forest management as in the case of K = 1, but with timber harvested at age 45–55).

K = 3, the sustained yield allowable cut assuming a level of forest management just sufficient to maintain the "allowable cut effect" (generally, this scenario was in effect immediately before the new legislation was enacted.)

K = 4, the sustained yield allowable cut assuming a level of forest management that corresponds generally to the level achieved in the Canada–Quebec forest development agreement. The impact of this level of activity is to **increase** the softwood AAC by 8 million m^3. This scenario corresponds generally to the level of forest management that will be achieved in the CAAF and, therefore, to the AAC of future years.

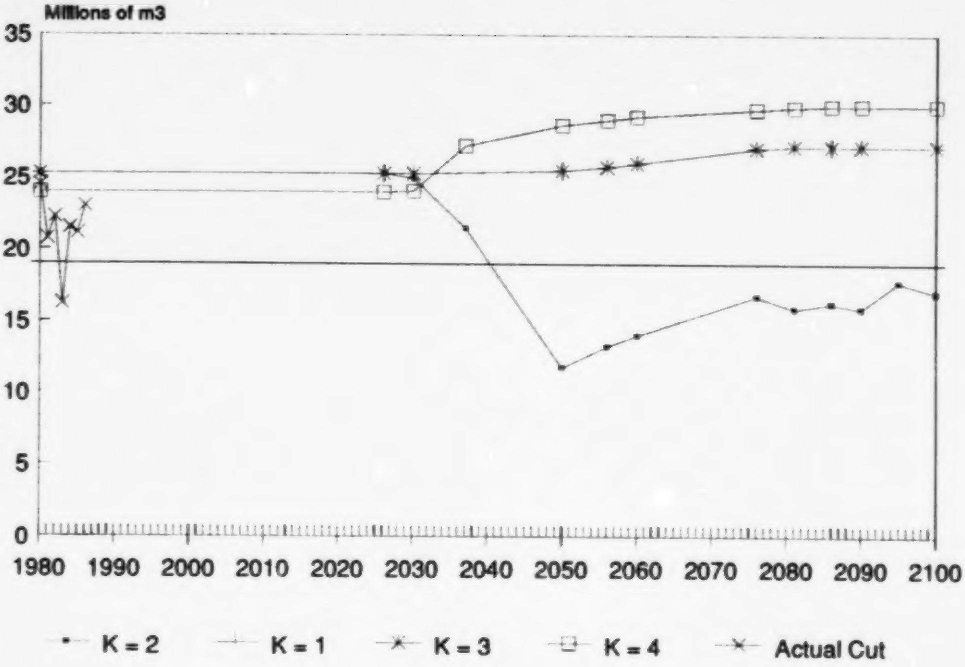


Figure A-22. Estimated softwood AAC for selected scenarios in Quebec, 1980–2100 (Quebec Department of Energy and Resources, 1988).

The simulations in Figure A-22 indicate that the future AAC is highly variable depending on the assumptions used. The most probable long-term supply outlook is favorable except for forecast deficits emerging for 3 decades beginning early in the next century. In the **long term**, changes in government forest policy and management, as well as heavy reforestation efforts conducted under the present agreement (1985–1990), will result in a forest resource with a more even distribution of age classes, and an increased AAC. The floor level for softwood AAC from Crown lands should be in the 26-million m^3 range. An additional 6 million m^3 should be available from private lands. Therefore, the long-term softwood AAC should be 32 million m^3 or more.

The magnitude of the forecast **medium-term** deficit will depend on several factors. First, more expensive fiber from the northern zone will likely be utilized. The cost of extracting this fiber will depend on the level of transportation infrastructure existing in the next few decades. Second, the fiber might also be made available by the province using incentives such as lower stumpage rates. Third, if the Canada–Quebec Forestry Agreement is renewed, it could emphasize stand-tending management treatments which will increase yields in the medium term. The extent to which these factors come into play will determine the severity (if any) of a medium-term supply problem.

In addition, the vast hardwood resource will probably be utilized to a greater degree than now. Although high quality hardwoods such as yellow birch, oak, and maple have been in short supply for some time, other species such as aspen and white birch are abundant. New technology that allows use of aspen in various pulping processes and products such as oriented strand board could facilitate substitution of hardwoods for softwoods in some regions of the province.

7.7 New Brunswick

7.7.1 The Physical Resource Stock and Its Characteristics

The Forest Land Base

New Brunswick has slightly more than 6 million ha of inventoried productive forest land or 2.5% of the total for Canada (Figure A-23). Of all provinces, New Brunswick has the highest proportion of inventoried productive forest land to the total forest land area (87.9%) (Table A-30). A high percentage of this area is stocked and nonreserved.

Ownership of productive forest land is almost equally divided between provincial Crown with 2.96 million ha (48.6%) and private with 2.98 million ha (49.6%). The remaining portion of 0.15 million ha is federal Crown. Private land is divided between private woodlots (30%) and industrial (20%). New Brunswick has an estimated 30 000 small private forest owners.

The majority of forest land area in New Brunswick (50.4%) is occupied by stands of mature and overmature trees 55 years old and older. This age-class structure results largely from the

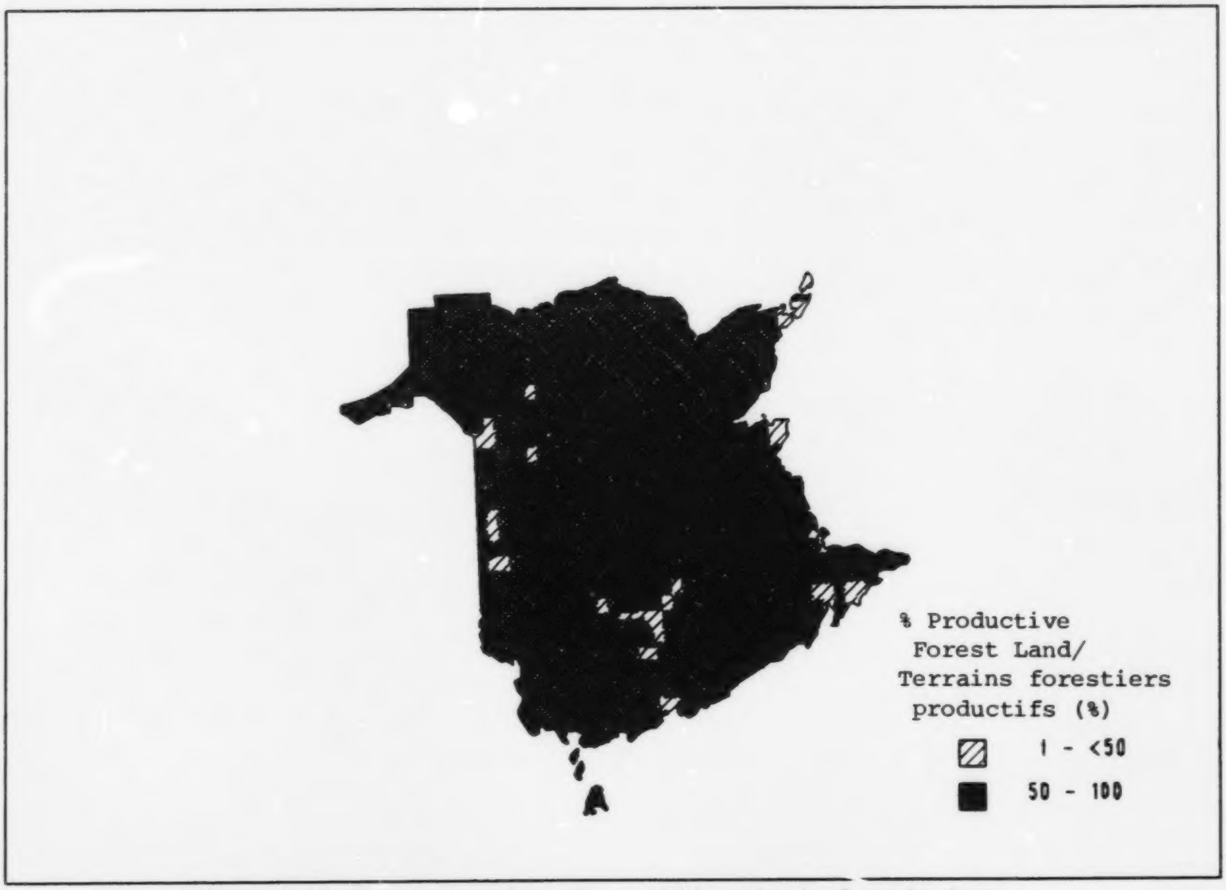


Figure A-23. Distribution of New Brunswick's productive forest land area (Petawawa National Forestry Institute, Forestry Canada).

Table A-30. Area classification in New Brunswick.

	Area	Percent of Total Land Area
	1 000 000 ha	
Total Land	**7.21**	**100.0**
Forest Land	6.34	87.9
Inventoried	6.34	87.9
Productive	6.09	84.5
Unproductive	0.24	3.3
Unspecified productivity	–	–
Noninventoried	–	–
Nonforest Land	0.87	12.1
Water	**0.14**	
Total Area	**7.35**	

Source: *Canada's Forest Inventory 1986* (Forestry Canada, 1989).

Table A-31. Area of productive, nonreserved forest land by stocking class and maturity in New Brunswick.

Class	Area	Percent of Stocked Area
	1 000 000 ha	
Nonstocked and unproven stocking	**0.38**	–
Stocked	**5.68**	**100.0**
Regeneration	0.16	2.8
Immature	2.66	46.8
Mature & overmature	2.86	50.4
Uneven-aged	0.01	0.2
Unclassified	–	–
Total	**6.07**	

Source: *Canada's Forest Inventory 1986* (Forestry Canada, 1989).

severe spruce budworm outbreak from 1910 to 1920. Approximately the same area is classified as supporting immature stands, while only a small portion of the forest is in regeneration status (Table A-31). Much of the area in the immature class, (30%) is less than 25 years old and the remainder (about 15%) is between 25 and 50 years old. This structure in the immature age class is primarily a result of past harvesting practises.

The Growing Stock

Most of New Brunswick is located in the Acadian Forest Region which is closely associated with the Boreal, Great Lakes-St. Lawrence, and Deciduous regions. Almost two thirds of the gross merchantable volume (362 million m^3) is in softwood species, mainly spruces (black, white,and red), balsam fir, jack pine, and white pine. Volume in hardwoods totals almost 210 million m^3, and consists primarily of maple, birch, and aspen/poplar (Table A-32).

Table A-32. Inventory by species, all maturity classes in New Brunswick.

Species	Volume	Percent of Total
	1 000 000 m^3	
Softwoods	**362**	**63.4**
Spruce	168	29.4
Pine	23	4.0
Fir	120	21.0
Other/unspecified	50	8.8
Hardwoods	**209**	**36.6**
Aspen/poplar	42	7.4
Birch	57	10.0
Maple	87	15.2
Other/unspecified	24	4.2
Total	**571**	**100.0**

Source: *Canada's Forest Inventory 1986* (Forestry Canada, 1989).

7.7.2 Current Status of Timber Supply (AAC)

Methods and Principal Assumptions

The basic management objective of the New Brunswick Department of Natural Resources (NBDNR) is to "provide a harvest level which can be sustained in the future and which evens out the age class distribution" (Canada/New Brunswick Forest Renewal Agreement, 1984-1989).

Provincial Crown lands (about 3 million ha, 48.6% of total productive land) is governed by the Crown Lands and Forests Act which came into effect April 1, 1982. The principal aims of this act were to reallocate Crown forest lands, and integrate basic management functions of harvest scheduling, allocation, protection, and silviculture. These aims were established to ensure that industrial timber requirements would be met and that due consideration was given to other forest uses such as recreation, fish and wildlife, and watershed protection.

In addition, this act established the policy that the Crown would be the residual supplier of timber. The rights to Crown timber would only be determined after available supplies from private woodlots, industrial freehold, and imports were considered.

Crown forest land in the province is currently allocated to 10 licensees (Figure A-24). Eight of the licensees are pulp and paper companies, one is a waferboard producer, and one is a lumber manufacturer.[1] Licensees are responsible for (a) a 10-year industrial plan showing expected plant investment, capacity, etc., revised every 5 years; (b) a 25-year management plan indicating management objectives for resources that are to be used, management activities including silviculture, harvesting, protection, road construction, recreation, fish and wildlife, etc., revised every 5 years; and (c) a 1-year operating plan showing expected source of timber from small private lands, company controlled lands, and other sources, to be updated annually. Approximately 140 sublicensees are located within the 8 larger licence areas. These sublicensees are persons or

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[1] A licensee must own or operate a wood processing facility in the province or undertake to construct and operate a facility (New Brunswick Dept. Natural Resources and Energy, Crown Lands and Forests Act, 1983).

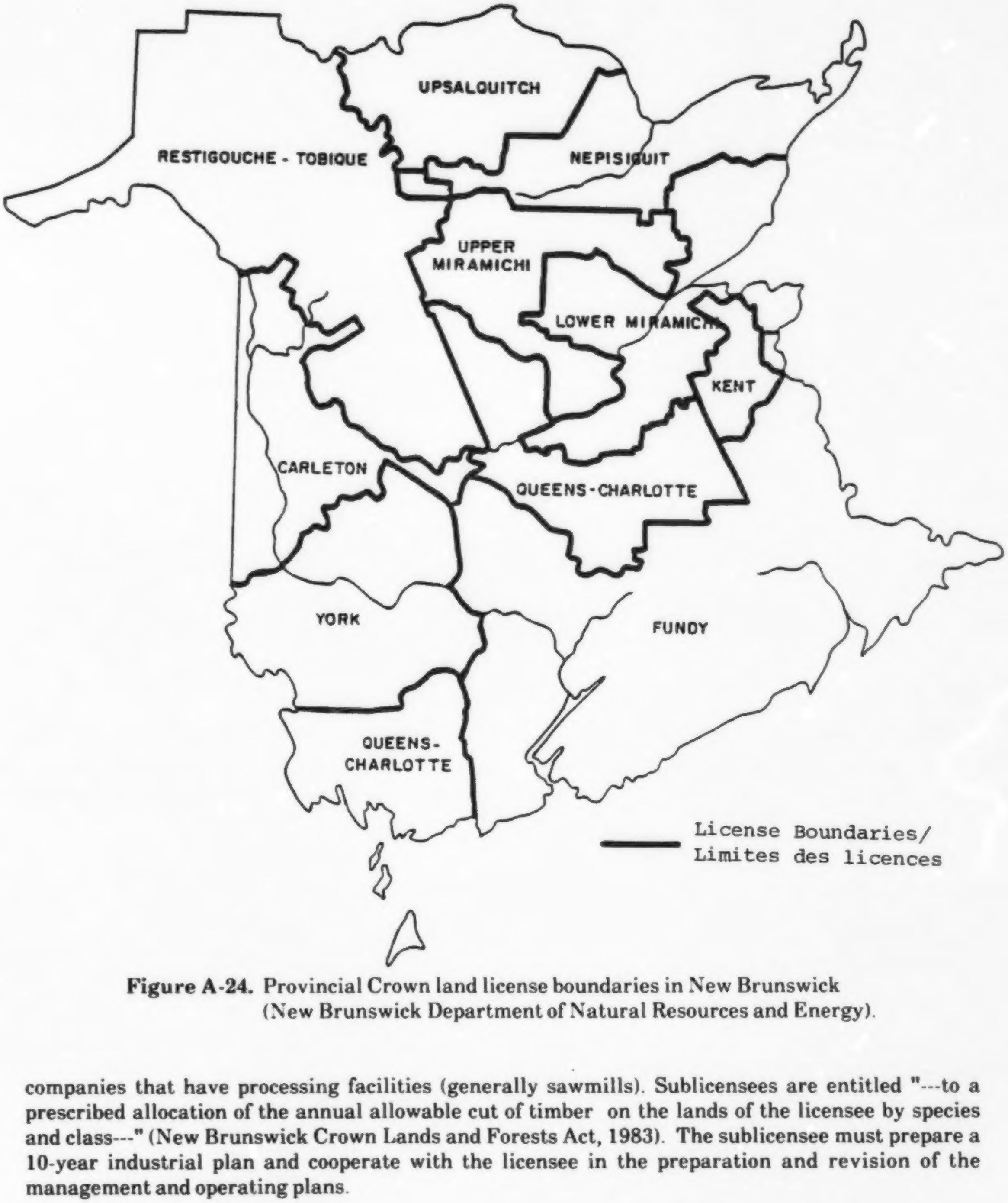
UPSALQUITCH
RESTIGOUCHE - TOBIQUE
NEPISIGUIT
UPPER MIRAMICHI
LOWER MIRAMICHI
KENT
CARLETON
QUEENS-CHARLOTTE
YORK
FUNDY
QUEENS-CHARLOTTE
License Boundaries/
Limites des licences

Figure A-24. Provincial Crown land license boundaries in New Brunswick (New Brunswick Department of Natural Resources and Energy).

companies that have processing facilities (generally sawmills). Sublicensees are entitled "---to a prescribed allocation of the annual allowable cut of timber on the lands of the licensee by species and class---" (New Brunswick Crown Lands and Forests Act, 1983). The sublicensee must prepare a 10-year industrial plan and cooperate with the licensee in the preparation and revision of the management and operating plans.

Timber supply analysis in New Brunswick is tenure specific. Analyses for licensed Crown land are currently conducted by the licensee with the cooperation of the provincial Department of Natural Resources (NBDNR). Analyses for industrial freehold lands are done by the owners, and for private woodlots by NBDNR in cooperation with Marketing Board staff. The availability of commercial timber from federal lands is determined by Forestry Canada, Maritimes Region.

The FORMAN (FORest MANagement) model is used to calculate AACs for licensed lands and private woodlots.[2] FORMAN is a simulation model that tracks forest inventory over time given initial stock characteristics, growth assumptions, removals, and silvicultural treatments. Regarding the land base for licensed lands, areas such as riparian zones, deer wintering yards, ecological reserves, and those with extreme slopes are removed. On private woodlots, 100% of the land base is assumed to be available for timber harvesting.

Some of the principal assumptions in the calculation of AAC are:

a) insect losses are reflected in the yield curves;
b) no reduction is assumed for fire loss (where a large fire loss occurs, the model is re-run);
c) operability limits are based on a minimum of 50 m^3/ha on Crown and industrial freehold lands and 40 m^3/ha on private woodlots;
d) harvesting on Crown and medium freehold lands is assumed to be controlled and targeted (for example, user-defined priorities may be to minimize unharvested primary volume/loss, maximize harvested primary volume per hectare, etc.); on private woodlots no such harvest control is assumed.

Many of these assumptions can be changed to determine sensitivity of outcomes. The basic planning horizon is 80 years.

Current AAC

The most recent estimates of annual sustainable harvest levels (1988–1992) by land tenure and major products are shown in Table A-33. These estimates are the result of the second 5-year analysis since enactment of the Crown Lands and Forests Act of 1983. The total AAC is 8.10 million m^3 for softwoods including cedar and white pine, and 3.6 million m^3 for hardwoods.[3]

Table A-33. Annual sustainable harvest levels for New Brunswick by landowner group and major species, 1988–1992.

Owner	Species Group				
	Spruce/ Fir/Jack Pine	Eastern[a] Cedar	White[b] Pine	Total Softwoods	Total Hardwoods[c]
	1 000 000 m^3				
Provincial Crown	4.03	0.16	0.11	4.30	1.60
Industrial freehold[d]	1.72	0.06	0.02	1.80	0.75
Private woodlots[e]	1.75	0.12	0.04	1.91	1.18
Federal Crown	0.09	–	–	0.09	0.05
Total	**7.59**	**0.34**	**0.17**	**8.10**	**3.58**

[a] Solid product (double to get total fiber).
[b] Partial cut basis (40 cm dbh limit).
[c] Selected cut in hardwood stands.
[d] Based on adjacent Crown productivity.
[e] Assumes full availability over time.

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[2] For a detailed explanation of the FORMAN model and procedures see Wang, 1987 and Jamnick and Clements, 1988.
[3] Estimated AAC for 1984 to 1988 was 7.06 million m^3 of softwood and 2.7 million m^3 of hardwood (see Figure A-25).

This estimate of AAC is based on a silvicultural treatment of 28 241 ha per year (18 176 ha planted and 10 065 ha spaced).

AAC is roughly proportional to land area held by owner group. The largest percentage is on provincial Crown lands (51.7% of AAC and 48.6% of productive area), followed by private woodlots (26.6% of AAC and 30% of productive land) and industrial freehold (21.8% of AAC and about 20% of productive land). Federal government holdings account for only 1.2% of the AAC and 2.5% of the productive forest.

7.7.3 AAC Compared with Harvest

From 1977 to 1986, the average volume harvested and consumed in New Brunswick was 8.1 million m^3. An additional 0.3 million m^3 per year on average was harvested and exported. Average softwood harvest for this period was approximately 7.0 million m^3 while the figure for hardwoods was 1.1 million m^3.

The softwood roundwood harvest for domestic consumption during the period was slightly more than the AAC estimated for 1984 to 1988 (7.06 million m^3). If roundwood exports are added to the volume domestically consumed, production exceeded AAC by about 250 000 m^3. During the 4 years from 1983 to 1986/87, roundwood production exceeded the estimated AAC by 0.7 to 1.0 million m^3 (this includes exports of about 150 000 m^3). The softwood harvest in 1987, including exports was approximately 8.0 million m^3.

The most recent estimate of softwood AAC for the province (Table A-33) indicates that for all softwood species (including cedar and white pine) there might be a small surplus. This situation is reflected in Figure A-25. However, if more recent production figures were available, the current level of harvest would probably equal or exceed the estimated AAC.

Hardwood production in New Brunswick during the past 10 years (1977–1986/87) has averaged about 1.1 million m^3 per year excluding exports (Figure A-26). Hardwood exports have averaged about 125 000 m^3 per year for the same period. From Figure A-26, this harvest level is considerably below the estimated AAC of 2.7 million m^3 for 1984 to 1988 and 3.6 million m^3 for 1988 to 1992. The majority of the surplus hardwood, however, is in the poorer quality classes and species not currently in heavy demand.

7.7.4 Long-Term Timber Supply Outlook

As noted earlier, more than 50% of New Brunswick's forest lands are occupied by stands considered to be mature or overmature. These forests are in the process of deteriorating because of natural aging and are highly vulnerable to spruce budworm attack. The objective of NBDNR management is to sustain the current harvest level and normalize the age-class distribution.

The strategy for meeting this objective is to harvest "the mature to overmature forest at a level that is low enough to allow sufficient time for the young forested areas or silviculturally treated areas to reach sufficient maturity. A portion of the currently mature forest will have to be maintained for another 20–30 years to ensure a sustainable harvest. This will require careful harvest planning to ensure that the oldest and least vigorous stands are harvested first and the maintenance of an effective budworm protection program to prevent premature losses in this older forest " (Canada-New Brunswick Forest Renewal Agreement, 1984–1989).

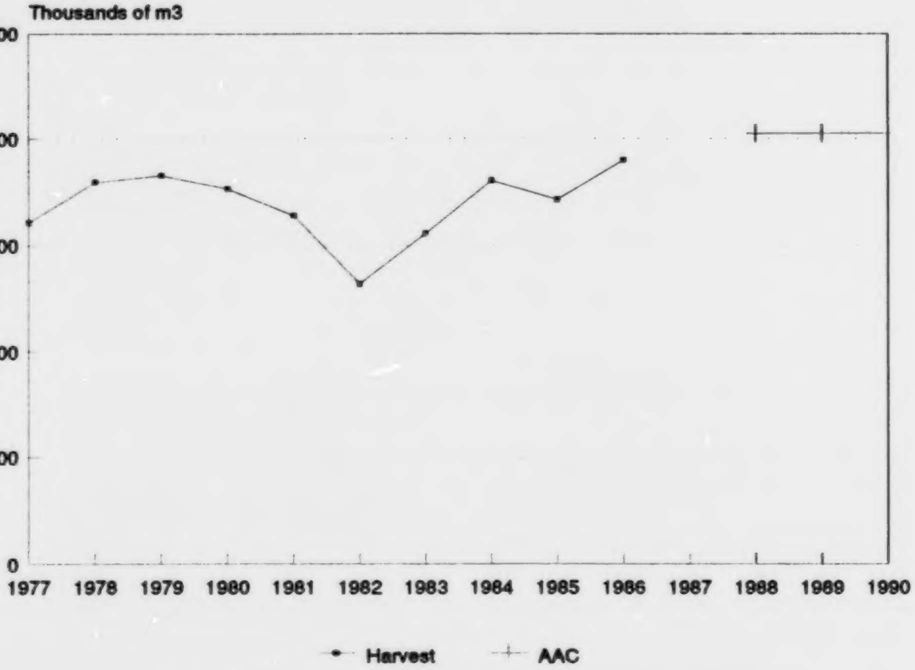

Figure A-25. Softwood timber harvest and AAC in New Brunswick.

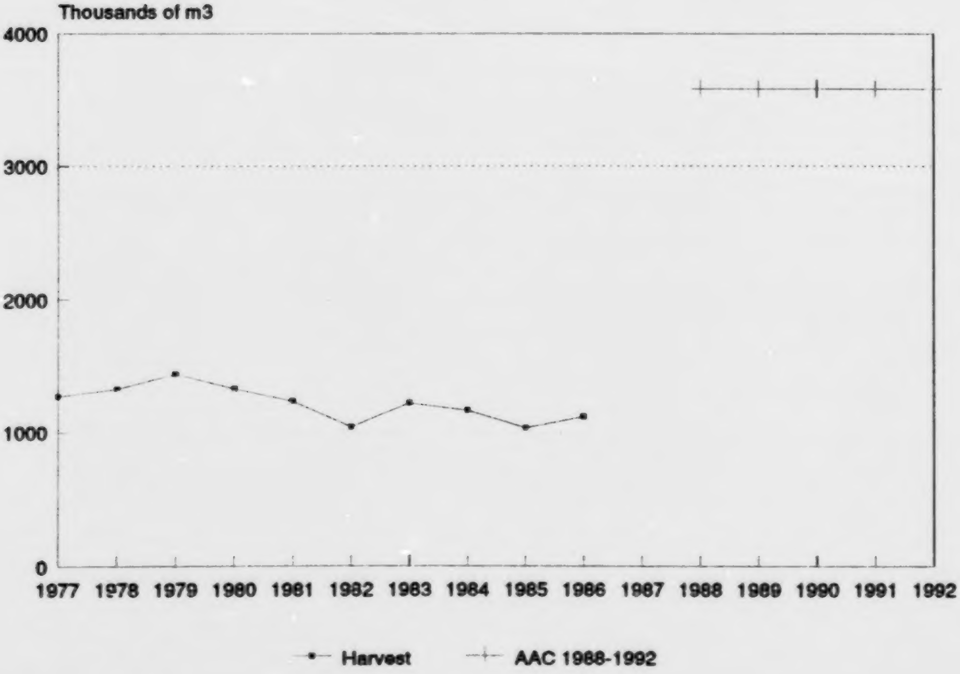

Figure A-26. Hardwood timber harvest and AAC in New Brunswick.

Analysis of roundwood utilization trends in the province indicates that about 7.5 million m^3 of softwood timber (excluding exports) is required annually from domestic sources. Adding export requirements increases the figure to approximately 8.1 million m^3. Given existing levels of budworm protection, harvest regulation, and a high availability from all ownerships, the sustained yield is about 5.4 million m^3 with no silvicultural inputs. Long-term supply analysis indicates that a softwood AAC of about 8.10 million m^3 can be expected with a silvicultural program of 28 200 ha treated annually.

New Brunswick's long-term softwood timber supply is much more critical than in most other provinces. The question is not whether the province can increase supply over current levels, but whether it can, in fact, maintain the current level. As in most other provinces, however, an opportunity exists for expansion of hardwood production. This opportunity depends on markets, and quality, quantity, and location of the resource. However, plans by industry indicate that this surplus of hardwoods could very well be utilized within the next 5 years. Increased utilization of hardwoods will help to ameliorate the softwood scarcity by releasing softwoods now located in the hardwood stands.

7.7.5 Conclusions

The timber supply in New Brunswick is critical. Past budworm outbreaks, silviculture, and harvesting practises have resulted in a forest that is predominantly (two thirds) softwood species. The majority of the forest stock is classified as mature or overmature. The problem is how best to schedule the harvest and protect this material while ensuring future crops are available at a time and in the quality/quantities required to maintain industrial viability. Further, these management strategies must consider increasing nonindustrial demands such as wildlife and recreation.

The forest industry currently requires about 7.5 million m^3 of roundwood softwood. This level of output appears to be sustainable, at least during the next 5 years. But the sustainability hinges on a continued and significant level of silvicultural input of some 28 000+ ha per year. Continued and effective protection of the forest from spruce budworm and fire is also required.

Forest land tenure in New Brunswick is different than in most other provinces in that about 30% of the productive area is held in private woodlots by approximately 30 000 owners. Many of these owners do not actively manage their lands for commercial forest products. Limited income prohibits many owners from undertaking silvicultural improvements. Historically, these lands have provided 25–30% of industrial roundwood requirements, but concern is growing about whether this level of output is sustainable.

A surplus of hardwood resources appears to be available in the province; however, this timber consists mainly of species of low quality fiber. Current and historical hardwood requirements are about 1–1.5 million m^3 annually. The most recent AAC is estimated to be 3.58 million m^3. Current industrial plans indicate that an additional 2 million m^3 of hardwoods will be required during the next few years.

7.8 Nova Scotia

7.8.1 The Physical Resource Stock and Its Characteristics

The Forest Land Base

Nova Scotia's total forest land base is slightly more than 4 million ha. Approximately 3.85 million ha (73%) is classed as inventoried and productive, (Table A-34 and Figure A-27) and represents 1.6% of Canada's total productive forest land. About two thirds of the forest land is estimated to be stocked and nonreserved.

The majority of forest land in the province is privately owned. Approximately 1.9 million ha (48.6%) is in small private properties (less than 400 ha), and 0.84 million ha (21.8%) is large private properties (greater than 400 ha). The provincial Crown owns 1.02 million ha (26.5%), and the remaining 0.11 million ha (2.9%) is in federal Crown ownership.

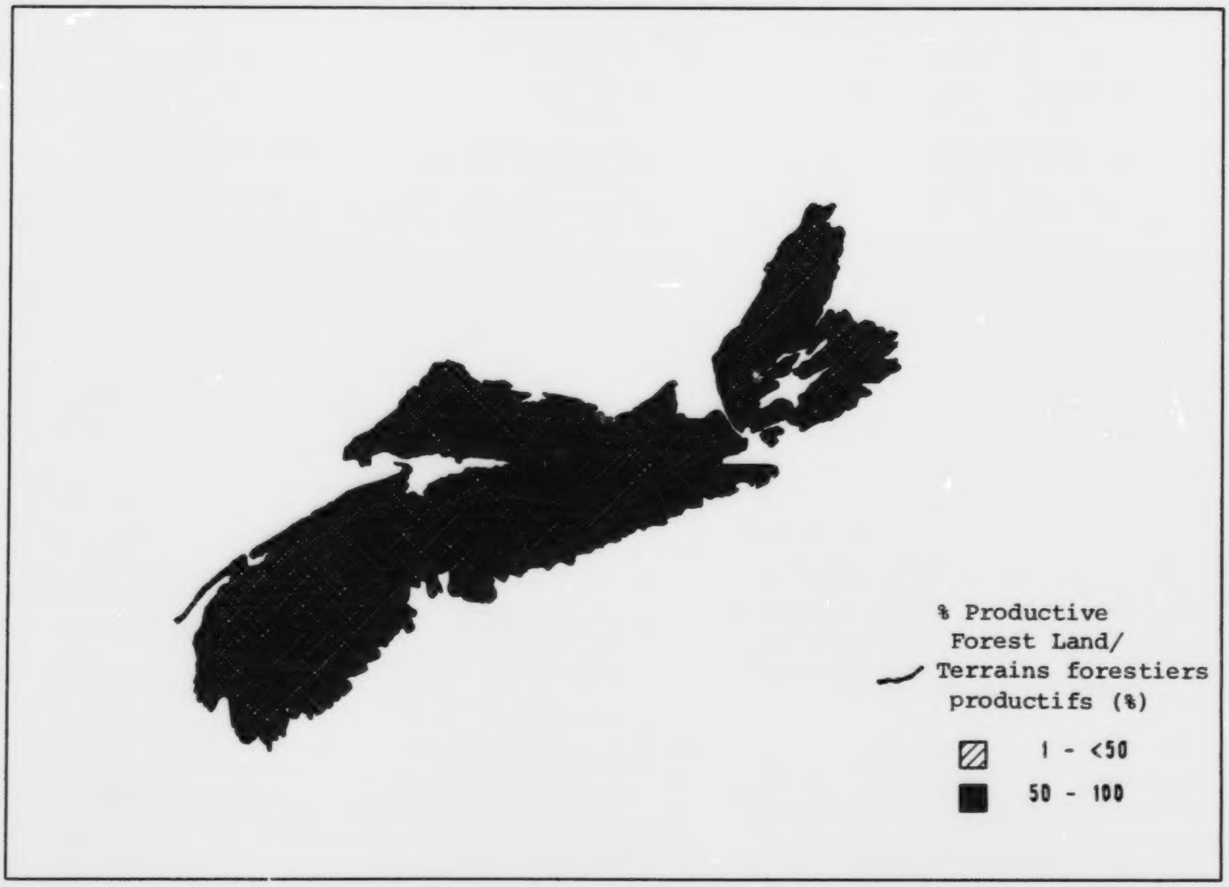

Figure A-27. Distribution of Nova Scotia's productive forest land area (Petawawa National Forestry Institute, Forestry Canada).

Table A-34. Area classification in Nova Scotia.

	Area	Percent of Total Land Area
	1 000 000 ha	
Total Land	**5.28**	**100.0**
Forest Land	4.04	76.5
Inventoried	4.04	76.5
Productive	3.85	72.9
Unproductive	0.19	3.6
Unspecified productivity	–	–
Noninventoried	–	–
Nonforest Land	1.24	23.5
Water	**0.27**	
Total Area	**5.55**	

Source: *Canada's Forest Inventory 1986* (Forestry Canada, 1989).

Table A-35. Maturity class of productive, stocked, and nonreserved forest land in Nova Scotia.

Class	Area	Percent of Stocked Area
	1 000 000 ha	
Nonstocked and unproven stocking	**0.50**	–
Stocked	**3.25**	**100.0**
Regeneration	0.09	2.8
Immature	2.15	66.2
Mature & overmature	0.79	24.3
Uneven-aged	0.21	6.5
Unclassified	–	–
Total	**3.75**	–

Source: *Canada's Forest Inventory 1986* (Forestry Canada, 1989).

One of the major forest management problems facing Nova Scotia is the unbalanced age-class distribution (Table A-35). The problem is that a large portion (24.3%) of the land area is in mature and overmature ages (61 + years). In the immature category, more than one third of the total area is actually occupied with trees which are 40-60 years old. In total, therefore, approximately 60% of the province's land area is stocked with trees that are overmature, mature, or will be mature within 20 years. As in many other provinces, the management problem is how best to schedule the harvest from mature and overmature stands so as to maintain a regular or even flow of commercial timber, while concurrently ensuring that areas now regenerating will meet future needs.

Table A-36. Inventory by species, all maturity classes in Nova Scotia.

Species	Volume	Percent of Total
	1 000 000 m^3	
Softwoods	**150**	**61.5**
Spruce	85	34.8
Pine	12	4.9
Fir	43	17.6
Other/unspecified	10	4.1
Hardwoods	**94**	**38.5**
Aspen/poplar	7	2.9
Birch	23	9.4
Maple	54	22.1
Other/unspecified	10	4.0
Total	**244**	**100.0**

Source: *Canada's Forest Inventory 1986* (Forestry Canada, 1989).

The Growing Stock

Nova Scotia is classified ecologically as the Acadian Forest Region. Principal softwood species include red, white and black spruce, balsam fir, and white pine. Predominant hardwoods are red and sugar maple, yellow and white birch, and red oak.

Total gross merchantable volume on the inventoried, productive, stocked and nonreserved land is an estimated 244 million m^3 (Table A-36). Slightly more than 60% of this volume comprises softwood species such as spruce and balsam fir.

Hardwoods, mainly red and sugar maple, and yellow birch, make up the remaining 94 million m^3.

7.8.2 Current Status of Timber Supply (AAC)

Methods and Principal Assumptions

In 1986, the province of Nova Scotia announced a new forest policy that included eight objectives. Two of these objectives were (1) "Encouraging the development and management of private forest lands as the primary source of timber for industry in Nova Scotia, and (2) "A doubling of forest production by the year 2025."[1]

For wood supply analysis, the Nova Scotia Department of Lands and Forests delineates the province into three main regions — Eastern, Central, and Western (Figure A-28). Until the early 1970s, allowable cut was estimated using Von Mantel's formula. In the mid-1970s, simulation models were developed for use in AAC calculations. Presently, a second version of the SAWS model

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[1] Before introduction of this new policy, the principal objective as expressed in the Canada-Nova Scotia Forest Resource Development Agreement (1982–1987) was "To encourage and support forest management for the purpose of endeavouring to increase the sustainable supply of softwoods, to an average of 3.3 million cubic metres annually, from the forest resource to help ensure the continued viability and competitiveness of the present wood-based industry."

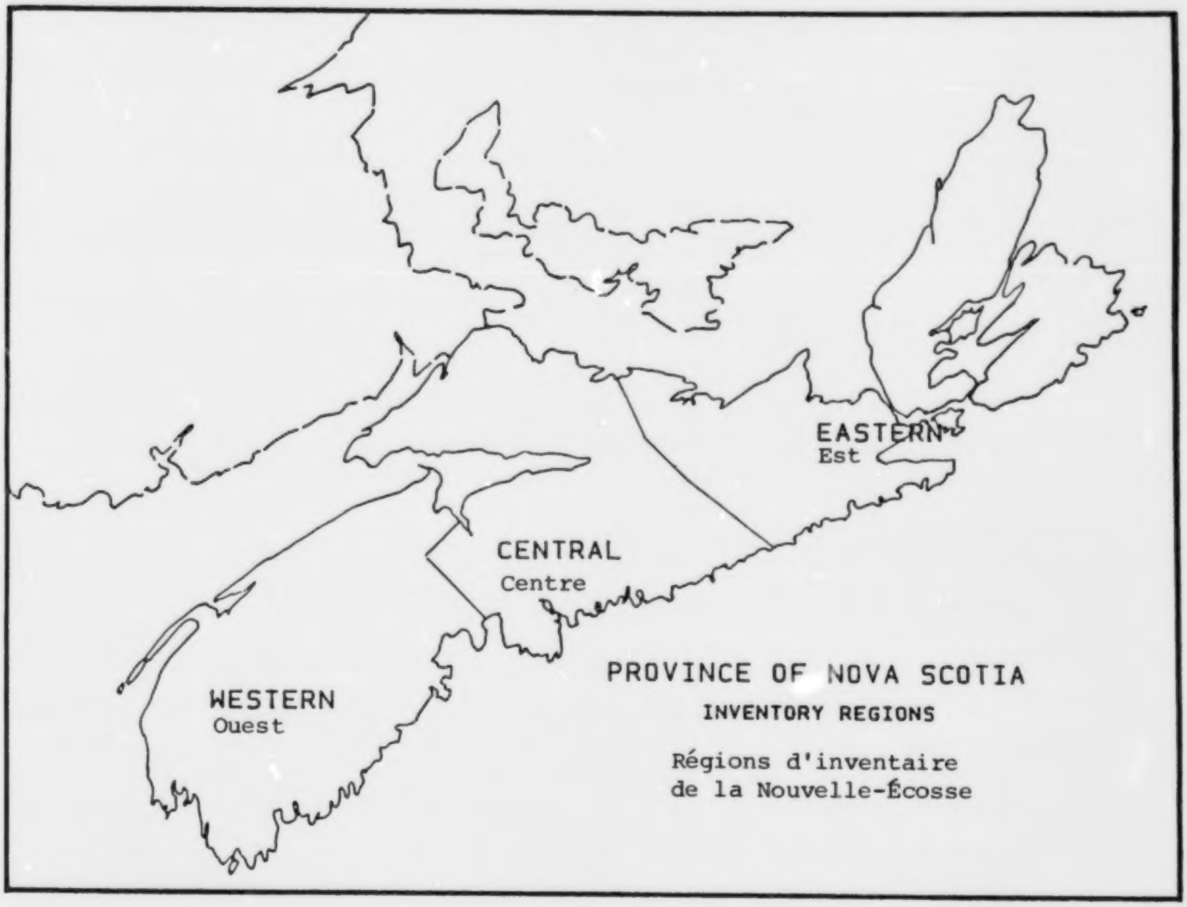

Figure A-28. Principal forest administrative regions in Nova Scotia (Nova Scotia Department of Lands and Forests).

(Strategic Analysis and Wood Supply) is used. Inventory is tracked over time given specified harvesting and silvicultural activities.[2]

Simulations with SAWS can be run on the basis of landowner group (Crown, large private, and small private) and various geographic jurisdictions (county, groups of counties, and province). The current simulation period is from the present to the year 2065.

Assumptions vary by simulation run but include percentage reductions to the land base for greenbelts, inaccessible and inoperable areas, cull and waste, and other volume losses; harvest and management rules, for example, oldest first, stocking level, site, or random; and level of silvicultural activity. Included in these initial assumptions are expected participation rates for private woodlot owners expressed as a percentage of the forest land area. Although participation rates can be varied by geographic region and policy scenario, on average about 65–75% of timber on these lands is assumed to be available for harvest.

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[2] A more detailed description of the SAWS model can be found in Bailey, 1987. See also Jamnick and Clements, 1988.

Table A-37. Estimated AAC in Nova Scotia.

Landowner	Softwood	Hardwood	Total
		1 000 000 m^3	
Provincial Crown	0.91	0.79	1.70
Industrial	1.05	0.42	1.47
Nonindustrial	1.54	0.63	2.17
Total	**3.50**	**1.84**	**5.34**

Source: Nova Scotia Department of Lands and Forests, 1986.

Current AAC

The AAC in Nova Scotia was estimated by the province in 1987–88 to be 3.5 million m^3 for softwood and 1.8 million m^3 for hardwood (Table A-37). These AAC figures refer to 1989 to 1995 and are based on the assumption that present levels of forest management would be sustained. The AAC for both softwood and hardwood is divided approximately 50–60% between industrial freehold and provincial Crown (25–30% each), and 35–45% for nonindustrial owners. Preliminary AAC estimates for 1990–91 are 3.4 million m^3 for softwood and 1.8 million m^3 for hardwood.

7.8.3 AAC Compared with Harvest

In 1987, the Nova Scotia forest industry comprised 4 pulp and paper mills, a hardboard plant, about 363 sawmills and a variety of other wood-using plants. The pulp and paper sector consumed approximately 70% of all softwood, with the balance accounted for by firms producing sawn products. Hardwood utilization is almost evenly distributed between industrial use and domestic fuelwood.

During the 10 years from 1977 to 1986, total consumption of roundwood in the province averaged about 3.8 million m^3. Softwoods accounted for an average of 3.2 million (85%) and hardwood 0.5 million m^3 (Figures A-29 and A-30). The harvest in 1986 and 1987 was 3.9 and 4.7 million m^3, respectively.

Production by ownership for the period 1977–86 shows that about 43% of the total harvest came from small private woodlots, 37% from large private, and the remaining 22% from provincial Crown lands. These percentages have remained relatively stable over time.

Figure A-29 shows a great variance in the softwood harvest relative to the AAC. From 1977 to 1986, the **average** AAC versus harvest was probably in balance. Until 1980, the harvest exceeded the AAC. The reverse situation occurred from 1981 to 1986. The apparent surplus during this 6 years reflects the recession of 1982 and a subsequent strike for one of the major pulp and paper mills. The situation since 1986 is of concern. Present harvest levels exceed the softwood AAC. Installed capacity softwood requirements in the province are estimated at about 3.6 million m^3 (Nova Scotia Dept. Lands and Forests, 1986). In addition, significant volumes are exported in roundwood form.

The hardwood availability/requirement balance essentially reflects the situation in many other parts of the country. As Figure A-30 indicates, from 1977 to 1986, average production of hardwoods was only about 1/2 million m^3 while AAC ranged from between 1.2 and 1.4 million m^3. The projected hardwood AAC for 1989 to 1995 is well above current consumption. The estimated capacity requirements for hardwoods are almost 1.3 million m^3 (Nova Scotia Dept. Lands and Forests, 1986).

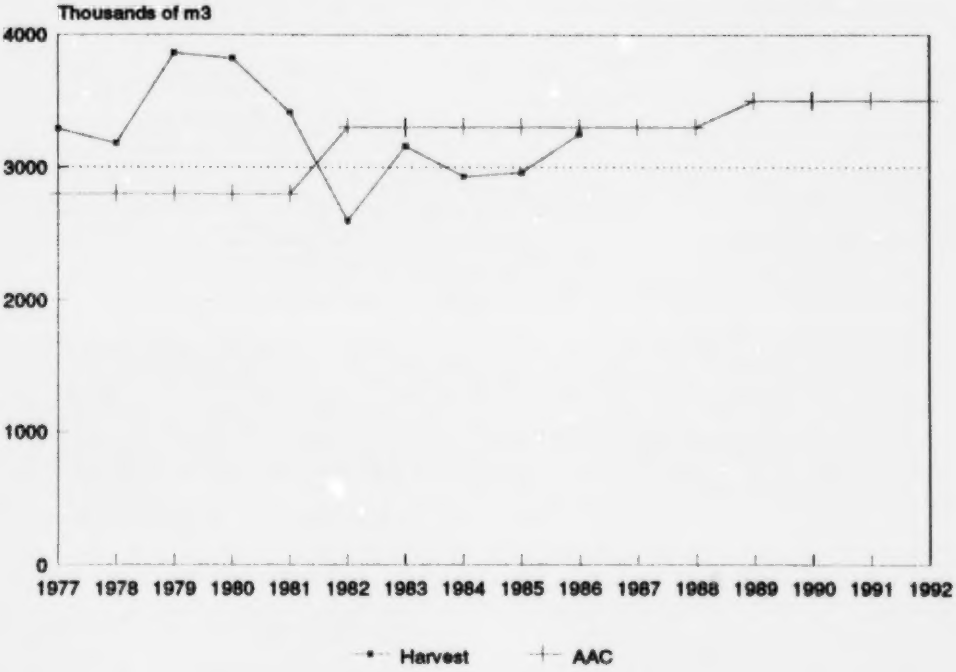

Figure A-29. Softwood timber harvest and AAC in Nova Scotia.

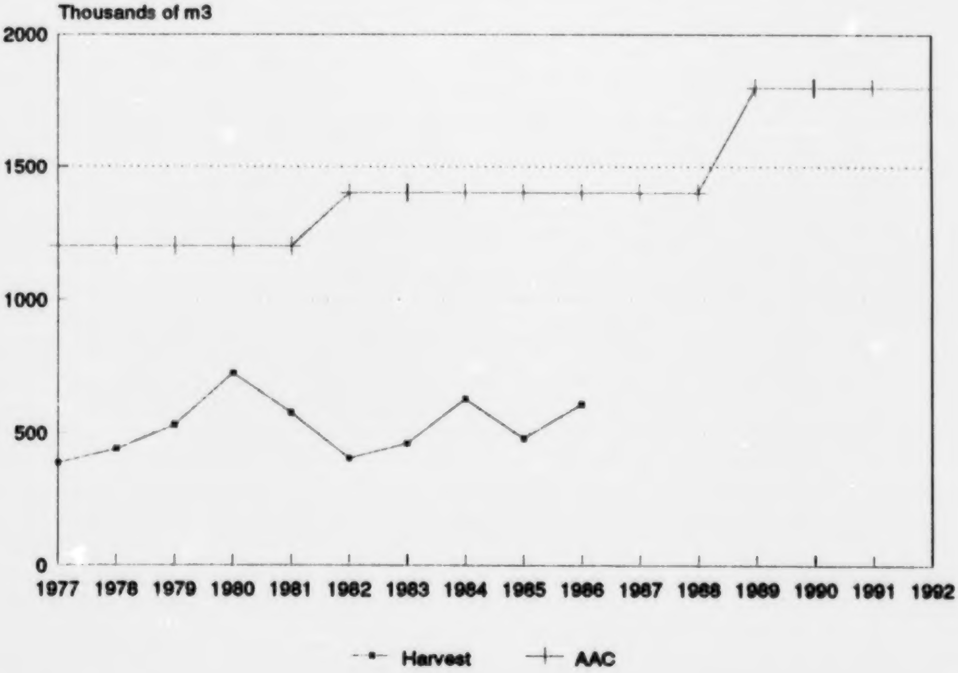

Figure A-30. Hardwood timber harvest and AAC in Nova Scotia.

7.8.4 Long-Term Timber Supply Outlook

Harvest scheduling, allocation, protection, and silvicultural inputs are the principal factors affecting timber supply. Because a large proportion of Nova Scotia's growing stock is in the mature and overmature stages, harvest scheduling and protection (from spruce budworm) are critical. Allocation of the harvest is important because imbalances currently exist in the geographic distribution of stock (relative to industrial requirements) due to past harvest patterns and outbreaks of spruce budworm Finally, silvicultural inputs obviously affect short- and long-term availability through impacts of treatments on current stands (cleaning, thinning) and on development of new stands (planting).

The effects of varying levels of silvicultural inputs were simulated for the 1990 to 2065 time period. (These simulations were carried out for the 1987–88 AAC calculations.)

1) The **nil** scenario represents a zero level of silvicultural inputs but with basic expenditures for fire and insect protection maintained. The softwood and hardwood AAC for this option are 2.5 and 1.8 million m^3, respectively.

2) The **maintenance level** (MA) scenario represents a level of input that would at least maintain the current softwood AAC at 3.5 million m^3. From 1990 to 2065, however, this level of input would, in fact, increase softwood AAC to slightly more than 5.0 million m^3. The hardwood AAC gradually rises to just slightly less than 3.0 million m^3. (This level of input includes planting of about 6000 ha annually, weeding of about the same area, cleaning on some 4000 ha, and thinning/shelterwood stand conversion on 2000 + ha.)

3) The **recent** scenario represents the average level of silvicultural input from 1982 to 1986. As shown, the softwood AAC rises to nearly 6.0 million m^3 by the year 2065. The hardwood AAC increases sharply by the year 2000, falls slightly, and then recovers to a level of less than 3.0 million m^3 by the year 2065. The level of silvicultural inputs is higher than in the previous scenario.

4) The **policy** level represents what the province feels would permit a doubling of softwood AAC to approximately 6.0 million m^3 by the year 2065. The silvicultural requirements for this expected level of AAC are basically double the maintenance level indicated previously. Adoption of this policy would mean that hardwood AAC would be expected to increase to more than 2.5 million m^3 by 2065. The impact of this scenario is much more pronounced on softwood supply than for hardwoods.

Sensitivity of Forecasts to Assumptions

The AAC projections are obviously sensitive to the assumptions made about future silviculture inputs, particularly for softwoods. The difference in softwood AAC in the year 2065 between the four scenarios is nearly 5.0 million m^3. Even assuming a modest average annual increase in wood consumption of 1.0%, softwood requirements in the year 2065 would be about 7.0 million m^3.

The variance in hardwood AAC among the four scenarios is only about 1.0 million m^3. Current hardwood requirements could double by the year 2065 and still be met by the AAC projected by all four scenarios.

7.8.5 Conclusions

The forest structure of Nova Scotia has been shaped largely by past harvesting practises and losses from fire, insects, etc., particularly the spruce budworm. Although in recent years considerable ups and downs can be seen, presently the softwood harvest exceeds the AAC, while for hardwoods a considerable surplus exists. The long-term outlook for softwood timber supply will depend primarily on the level of silvicultural inputs, both currently and in the future. A minimum level of silvicultural inputs is essential to maintain the softwood AAC at a level to sustain the current harvest. Provincial timber supply analyses indicate that with sufficient investments in the growing stock, the softwood AAC could be doubled by the year 2065. This level of investment may be necessary to expand timber supply to meet even a modest average growth in consumption of 1% per year. Because of the pattern of ownership in Nova Scotia, programs are needed to ensure continued intensive silvicultural activity on small, private nonindustrial holdings. The hardwood supply situation is more favorable both presently and according to long-term projections.

The province is currently revising its estimates of AAC and required levels of silviculture. This analysis will be completed in 1991.

7.9. Prince Edward Island

7.9.1 The Physical Resource Stock and Its Characteristics

The Forest Land Base

Prince Edward Island's forest land base totals 290 000 ha which represents about half the total land area for the province (Table A-38). Almost all this forest land is considered to be productive (Figure A-31) and nonreserved.

An estimated 16 000 forest land owners on the Island hold approximately 90% of the forest land. The remaining 10% of forest land is held by the province.

Data from *Canada's Forest Inventory 1986* (Forestry Canada, 1989) show that forest land by maturity group is unclassified (Table A-39). However, provincial data indicate that a majority of

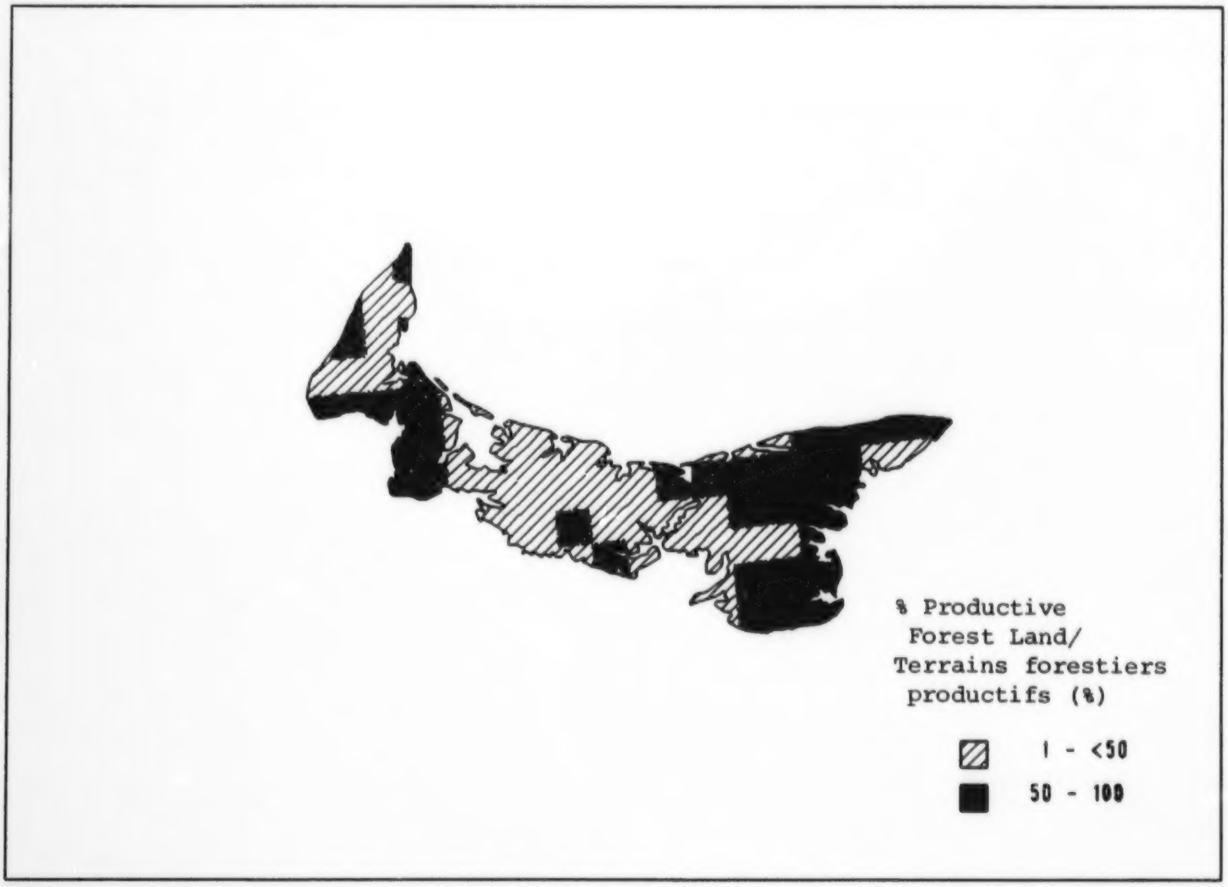

Figure A-31. Distribution of productive forest land in Prince Edward Island (Petawawa National Forestry Institute, Forestry Canada).

Table A-38. Area classification in Prince Edward Island.

	Area	Percent of Total Land Area
	1 000 000 ha	
Total Land	**0.57**	**100.0**
Forest Land	0.29	50.9
Inventoried	0.29	50.9
Productive	0.28	49.1
Unproductive	0.02	3.5
Unspecified productivity	–	–
Noninventoried	–	–
Nonforest Land	0.28	49.1
Water	–	–
Total Area	**0.57**	

Source: *Canada's Forest Inventory 1986* (Forestry Canada, 1989).

Table A-39. Maturity class of productive, stocked, and nonreserved forest land in Prince Edward Island.

Class	Area	Percent of Stocked Area
	1 000 000 ha	
Nonstocked and unproven stocking	**0.03**	–
Stocked	**0.25**	**100.0**
Regeneration	–	–
Immature	–	–
Mature & overmature	–	–
Uneven-aged	–	–
Unclassified	0.25	100.0
Total	**0.28**	**100.0**

Source: *Canada's Forest Inventory 1986* (Forestry Canada, 1989).

the area (64%) is occupied by stands older than 40 years, and only a small percentage of the area contains stands less than 30 years old. As discussed in earlier sections for other provinces, this age-class structure presents management problems relative to a forest management objective of even timber flow over time.

The Growing Stock

Historically, much of the forest land of Prince Edward Island was occupied by a variety of hardwoods characteristic of the Acadian Forest Region. These hardwoods included species such as

Table A-40. Inventory by species, all maturity classes in Prince Edward Island.

Species	Volume	Percent of Total
	1 000 000 m^3	
Softwoods	**16.7**	**64**
Spruce	10.4	40
Fir	5.2	20
Other/unspecified	1.1	4
Hardwoods	**10.4**	**40**
Aspen/poplar	2.0	8
Birch	2.0	8
Maple	5.2	20
Other hardwoods	1.2	4
Total	**26.1**	**100**

Source: *Canada's Forest Inventory 1986* (Forestry Canada, 1989).

red oak, beech, yellow birch, and sugar maple. The principal coniferous trees of this forest region include white, black and red spruce, and balsam fir.

The current condition of the Island's growing stock is described in a background statement from the Canada-Prince Edward Island Forest Resource Development Agreement, 1988–1993, as follows: "The softwood resource is characterized by large areas of mature to overmature white spruce and balsam fir, as well as lesser areas of red spruce, black spruce, and red spruce/black spruce hybrids. Individual stands originated either on agricultural lands abandoned between 1930 and 1950 or from selective cutting over the past 70 years. The agricultural land has subsequently regenerated to dense stands of white spruce, and the selective cutting has resulted in mixed wood stands with a high percentage of balsam fir."

The result of these past practises is an unbalanced age-class distribution in softwoods. Much of this forest area is in "old field" white spruce which begins to deteriorate at age 50. Due to high-grading of hardwood stands, the residual softwoods are often of small size and poor quality.

As in other eastern provinces, softwood volume makes up almost two thirds of the total. For Prince Edward Island, softwoods comprise an estimated 16 million m^3. Hardwoods, principally maple, birch, and aspen/poplar, total about 10 million m^3 (Table A-40).

7.9.2 Current Status of Timber Supply (AAC)

Methods and Principal Assumptions

In 1987, the province announced a new forest policy. The main objective of this policy is the enhancement of sustained economic, social, and environmental well-being of Islanders from the forests. This objective is to be accomplished through increased employment opportunities in the forest industry, "...substitution of imported softwood and hardwood lumber, fuels for space heating and electrical generation...", increased export of forest products, etc. (Prince Edward Island Dept. Energy and Forestry, 1987).

More specific elements of this overall policy include establishing harvest levels and management practises that will permit sustained yield while concurrently balancing the age-class distribution. Further, maintenance of a degree of natural diversity in species mix is felt to be important.

Wood supply projections are carried out using a version of the FORMAN (FORest MANagement) simulation model developed in New Brunswick. As indicated in the discussion of the procedures for New Brunswick, a net land base is identified after removing areas for environmental sensitivity, reserves, and stands considered inoperable because of low stocking, species, or quality suitability. Inventory for this net land base is tracked for a 100-year planning period given a set of assumptions for silvicultural inputs, harvesting, and yield. A harvesting rule is applied that harvests stands at greatest risk of natural volume loss first.

As in Nova Scotia, not all this timber volume is assumed to be available because of the land ownership. Prince Edward Island currently assumes that only 80% of the theoretical sustainable harvest level from private lands is available for consumption.

Three criteria are used in evaluating different scenarios. These are (1) age-class structure of the forest, (2) the product mix, and (3) the sustainability of the harvest for a 100-year planning horizon.

These criteria are weighted approximately equally, and trade-offs between any of the three may be made in determining the acceptability of the solution (Jamnick and Clements, 1988).

Current AAC

The estimated current AAC in Prince Edward Island is about 567 000 m^3, with softwoods accounting for 60% of the total (Table A-41). The majority of the AAC is classified as pulpwood or fuelwood quality with only a small proportion estimated to be sawlog material.

Table A-41. Estimated AAC in Prince Edward Island.[a]

Species Group and Product	AAC
	1000 m^3
Softwood	**341.5**
Sawlogs	82.0
Pulpwood/fuelwood	259.5
Hardwood	**225.0**
Sawlogs	5.0
Fuelwood	220.0
Total	**566.5**

[a] Figures are AAC estimates for 1985 based on the level of silvicultural inputs at that time. Estimates are for all ownerships, and assume 100% of potential is available for harvest. The hardwood volumes do not include species such as white birch, elm, ash, etc., which are currently not utilized to any large extent.

Source: Canada-Prince Edward Island Forest Resource Development Agreement, 1988–1993.

As indicated earlier, not all the AAC is thought to be available because of the land tenure. As in other provinces with a high proportion of private forests, the government has little jurisdiction over these lands and cannot regulate the volume of private timber harvests. However, the general assumption is that about 80% of the private land timber is available for commercial extraction. On Crown lands, 100% of the timber is assumed to be available for commercial use. The overall availability of timber from the total forest stock is an estimated 82% (80% of the 90% private land plus 10% Crown).

7.9.3 AAC Compared with Harvest

Prince Edward Island is the only province in Canada in which the harvest volume of hardwoods is approximately equivalent to that for softwoods. During the 10 years from 1977 to 1986, the average harvest on the Island was 270 000 m^3; almost 60% of this volume was softwood. In the 5 years from 1981 to 1985, the average harvest has increased to 346 000 m^3 with hardwoods comprising more than 50% of the total. In 1987, the total harvest had increased to an estimated 496 000 m^3.

Prince Edward Island is also unique in Canada in that the majority of the harvest is consumed as fuelwood. This situation is due largely to the high cost of fuel oil and electricity for residential heating. During the 5 years from 1981 to 1985, the average harvest of roundwood for fuel was more than 200 000 m^3 or 60% of the total harvest. In 1987, fuelwood production was an estimated 327 000 m^3 of which 75% was hardwood (Canada-Prince Edward Island Forest Resource Development Agreement, 1988–1993). In addition, several institutional buildings are now being heated with wood chips and the estimated requirement for roundwood is 35 000 m^3.

One of the principal uses of softwood roundwood on the Island is lumber production. Prince Edward Island has about 50 sawmills producing 16 million board feet of lumber per year, or about half the current domestic requirements. Annual sawlog consumption represents approximately 75 000 m^3 of roundwood, most of which is softwood.

The other main demand for roundwood is export pulpwood. Traditionally, sizeable volumes of pulpwood have been exported to Europe and other Maritime provinces. These exports occur because Prince Edward Island has no pulp and paper mills. The quantity of exports to adjacent provinces in the early to mid-1980s was quite low due to the large surplus of budworm damaged timber in these markets and depressed pulp and paper markets. More recently, however, demand for pulpwood has increased and shipments in 1987 were an estimated 60 000 m^3.

Roundwood harvest trends in Prince Edward Island compared with the estimated AAC indicate an apparent softwood surplus of about 145 000 m^3 in the mid-1980s (Figure A-32). This surplus is calculated as the AAC of 341 500 m^3 less 1985 harvest of 195 000 m^3. The majority of this surplus AAC is in pulpwood quality material. One of the major concerns in Prince Edward Island is the shortage of high quality sawlogs.

The hardwood harvest/AAC balance is much closer (Figure A-33). In fact, the 1985 harvest was 221 000 m^3 compared with the AAC of 225 000 m^3. As in softwoods, only a small proportion of the hardwood AAC is sawlog quality material.

7.9.4 Long-Term Timber Supply Outlook

Assuming the current level of silvicultural inputs is maintained, the softwood timber supply for the Island is expected to increase from 341 500 m^3 (1985) to about 450 000 m^3 by the year 2030.

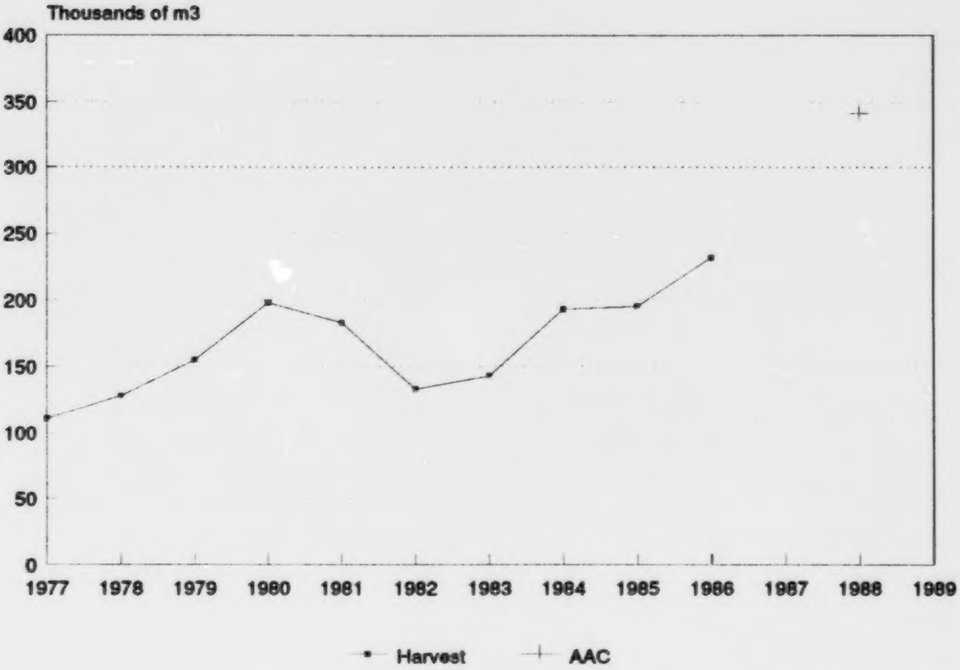

Figure A-32. Softwood timber harvest and AAC in Prince Edward Island.

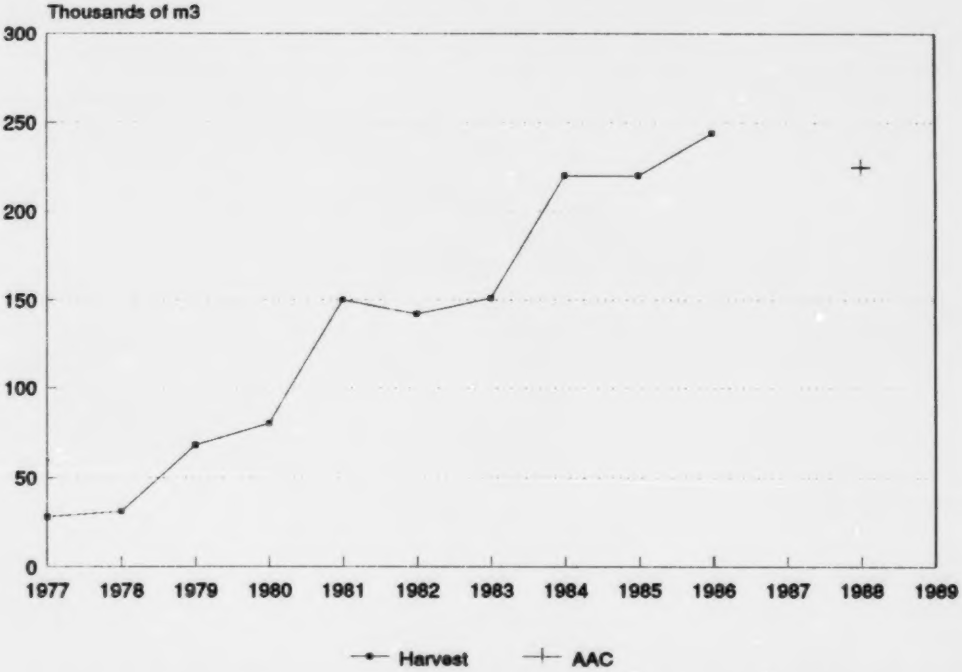

Figure A-33. Hardwood timber harvest and AAC in Prince Edward Island.

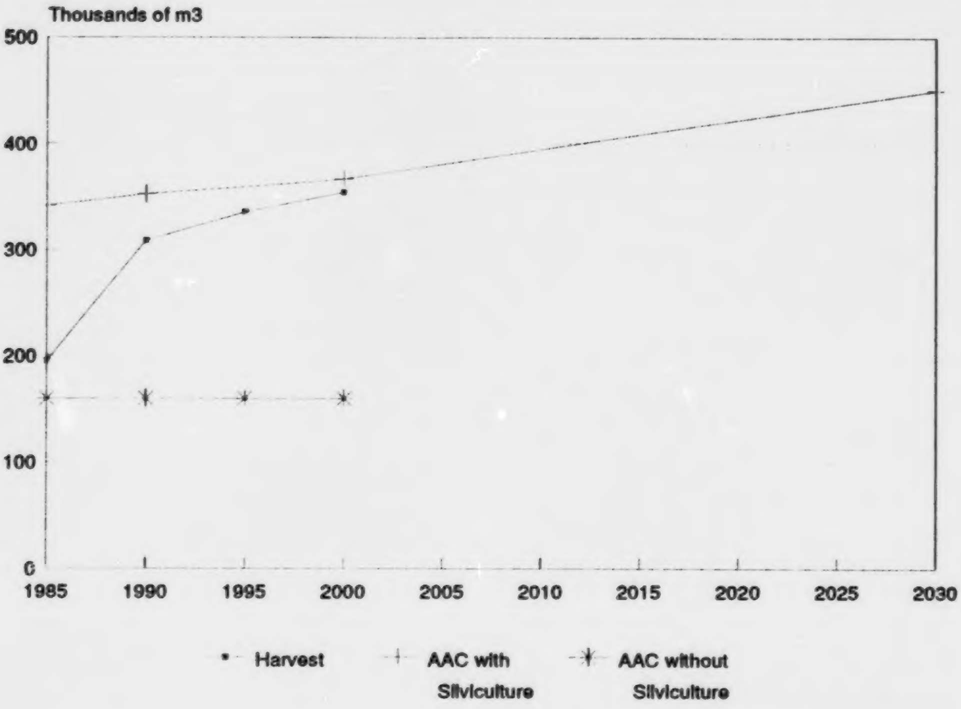

Figure A-34. Estimated softwood AAC in Prince Edward Island with and without silviculture, and anticipated demand (Prince Edward Island Department of Energy and Forestry, 1988).

This increase is expected to be in sawlog quality material. Without this silvicultural program, the current softwood AAC (without silviculture) of 160 000 m^3 is projected to decline slightly and then increase somewhat by the year 2030 (Figure A-34).

Clearly, the estimates of softwood timber demand to the year 2030 can only be met if current silviculture programs are maintained. Much of the increase in AAC will have to come from private lands. In response to this challenge, the present Canada-Prince Edward Island FRDA has a major goal of improving the level of management on private forests. Financial incentives for private forest land owners are included in FRDA programs.

The outlook for hardwoods is that the AAC can be sustained at a level of 220 000 m^3 per year given that current programs of thinning and stand conversion are maintained. These programs generally treat 400 ha per year. Without this silvicultural program, the sustainable level of harvest is estimated to be 179 000 m^3 per year.

7.10 Newfoundland

7.10.1 The Physical Resource Stock and Its Characteristics

The Forest Land Base

Recent data provided in Canada's Forest Inventory 1986 indicate about 11.2 million ha of productive forest land in Newfoundland (both Labrador as well as the Island) (Figure A-35). This figure (Table A-42) varies considerably from the province's Department of Forestry and Agriculture's (DFA) estimate of 6.5 million ha of productive forest land (DFA Twenty-Year Plan 1989). These estimates differ because the province excludes areas which although biologically productive (capable of producing >35 m^3/ha at rotation) are extensively scattered and therefore considered uneconomic.

All of the productive forest land in Labrador and slightly less than 90% of the Island's productive forest is provincially owned. Approximately two thirds of the Crown forest land on the

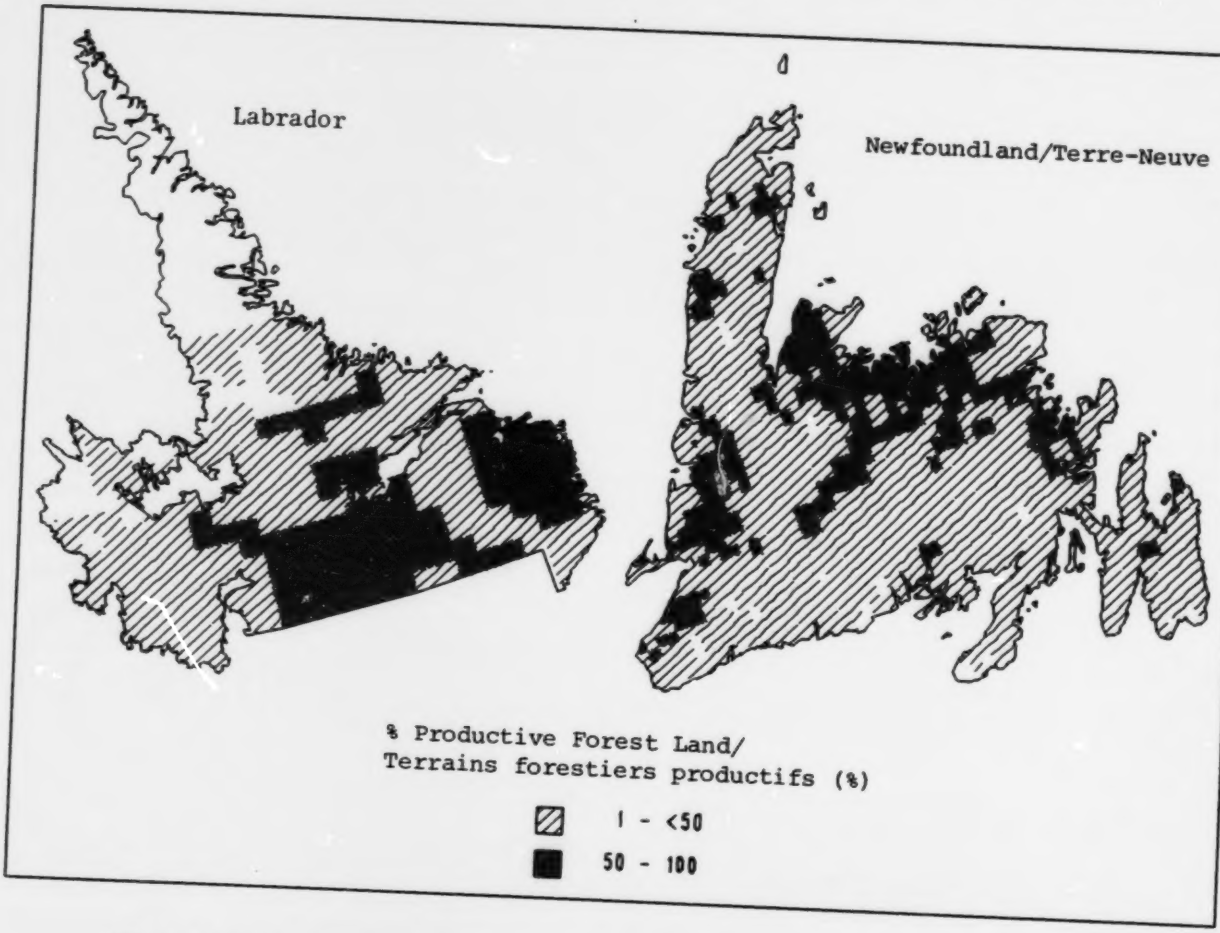

Figure A-35. Distribution of productive forest land in Newfoundland and Labrador (Petawawa National Forestry Institute, Forestry Canada).

Table A-42. Area classification in Newfoundland.

	Area	Percent of Total Land Area
	1 000 000 ha	
Total Land	**37.17**	**100.0**
Forest Land	22.48	60.5
Inventoried	22.48	60.5
Productive	11.18	30.1
Unproductive	11.30	30.4
Unspecified productivity	–	–
Noninventoried	–	–
Nonforest Land	14.69	39.5
Water	**3.40**	
Total Area	**40.57**	

Source: *Canada's Forest Inventory 1986* (Forestry Canada, 1989).

Table A-43. Area of productive, nonreserved forest land by stocking class and maturity in Newfoundland.

Class	Area	Percent of Stocked Area
	1 000 000 ha	
Nonstocked and unproven stocking	**3.47**	–
Stocked	**7.63**	**100.0**
Regeneration	–	–
Immature	0.61	8.0
Mature and overmature	2.14	28.0
Uneven-aged	–	–
Unclassified	4.89	64.1
Total	**11.10**	

Source: *Canada's Forest Inventory 1986* (Forestry Canada, 1989).

Island is under long-term lease or license to the pulp and paper industry. These forests are located mainly in the interior region and occupy the more productive sites. The remaining Crown forest land is classified as unalienated and is located primarily in the coastal regions of the Island.

The 1986 National Forest Inventory data show that only 28% of the province's productive, stocked forest land is occupied with mature and overmature trees (Table A-43). However, more recent provincial government information indicates that virtually all Labrador's forests are more than 40 years old. For the Island, approximately 45% of the productive forest area is more than 60 years old, 35% is 40–60 years old, and about 20% is less than 40 years old.

Table A-44. Inventory by species, all maturity classes in Newfoundland.

Species	Volume	Percent of Total
	1 000 000 m^3	
Softwoods	**487**	**92.8**
Spruce	107	20.4
Fir	117	22.3
Other/unspecified	263	50.1
Hardwoods	**38**	**7.2**
Aspen/poplar	3	0.6
Birch	26	5.0
Other/unspecified	10	1.9
Total	**525**	**100.0**

Source: *Canada's Forest Inventory 1986* (Forestry Canada, 1989).

The Growing Stock

Both the Island proper and Labrador form the most eastern portion of the Boreal Forest Region. Forests in this region consist of relatively small, primarily coniferous trees intermixed with hardwoods. The variety of species is relatively poor. Due to cool moist climates, nutrient cycling is slow and poorly drained podzolic soils have developed. Repeated fires have established black spruce as a characteristic species, but where sites are more favorable white spruce may occur.

Newfoundland's forests comprise approximately 93% softwood species (Table A-44). Balsam fir is the most common species on the Island and the second most abundant in Labrador. The reverse situation occurs for black spruce. Other main species include aspen/poplar, birch, and larch.

The 1986 Canada Forest Inventory estimated the total merchantable volume on productive, stocked, and nonreserved land at 525 million m^3. The recent provincial Twenty-Year Plan (Newfoundland Dept. Forestry and Agriculture, 1989) estimates the gross merchantable volume on the Island's productive forest at 198 million m^3. For Labrador, the total gross merchantable volume from productive forests with development potential (6.5 million ha) is an estimated 53 million m^3. These differences between federal and provincial estimates reflect the global nature of the national inventory compared with the more intensive provincial inventory which omits regions of Labrador with low development potential.

7.10.2 Current Status of Timber Supply (AAC)

Methods and Principal Assumptions

Several key policies governing forest management in Newfoundland resulted from the Report of the Royal Commission on Forest Protection and Management of 1981. The main recommendation of this report was that "... an accelerated program of intensive silviculture be undertaken in an attempt to offset projected wood supply shortages." The commission also recommended "...that the current system of long-term timber licenses be replaced by twenty year, renewable forest management agreements." These recommendations and others have been accepted by the provincial government and will set the tone for forest policy formulation in the next several decades. The recent DFA Twenty-Year Plan (1989) indicated that "the highest priority issue to be dealt with over the next 20 years (and beyond) is the impending wood supply shortage..."

The AAC for the province is calculated for 10-year periods for the next 80 years an area approach with some volume control. The forest land area included in the calculation represents the net land base which is considered available for harvesting and for which forest management has priority over other uses. Actual accounting for silvicultural inputs, harvesting, and inventory development is done using a version of the FORMAN model originally developed in New Brunswick. Estimates are presented for a period of 2 decades in the recent Twenty-Year Plan by tenure as opposed to the earlier approach of assessing supply by administrative zones. Thus, estimates of timber supply can be compared directly with the wood requirements of the three newsprint mills as well as the various commercial and noncommercial fiber demands on unalienated Crown lands.

Twenty-four assumptions are made in calculating AAC relating to (1) the availability of land for commercial timber production; (2) regeneration; (3) silviculture; (4) management strategies; and (5) inherent characteristics of the FORMAN model. Some of the more salient assumptions relate to strategy:

1) Stands are queued for harvest according to an oldest first harvest rule.

2) Operability limits are 90 m^3/ha on the rising part of the yield curves and 80 m^3/ha on the falling part of the curves.

3) Present levels of silviculture are continued for the 80-year simulation period.

4) The objective of the analysis is to establish maximum sustainable harvest levels for consolidated company holdings across management unit boundaries and residual AACs for Crown limits within each management unit.

5) All maximum sustainable harvest levels are reduced by 25% subsequent to running the model to reflect utilization losses resulting from poor or incomplete harvesting practises.

Current AAC

Current AAC for Newfoundland is estimated to be almost 3.01 million m^3, all of which is softwood. Approximately 80% of this supply is from the Island and the remainder is from Labrador (Table A-45).

Table A-45. Estimated softwood AAC in Newfoundland by tenure.

Location and Tenure	Current AAC
	1000 m^3
Island	2410
Industry limits	1835
Unalienated Crown	575
Labrador	600
Total	**3010**

Source: Newfoundland Department of Forestry and Agriculture, 1989.

7.10.3 Current AAC Compared with Harvest

Average annual harvest of softwood in Newfoundland from 1977 to 1986 has been approximately 2.4 million m^3. Hardwood harvest has averaged slightly less than 50 000 m^3 per year. The softwood harvest has been relatively stable during this period with minor fluctuations due to changes in pulpwood requirements relative to newsprint markets (Figure A-36).

The total softwood harvest on the Island in 1989 was an estimated 2.979 million m^3. The main reason for the jump in wood consumption compared with the 1977–1986 average is the increased pulpwood requirements from recent capacity expansion and from modernization in one of the three newsprint mills on the Island. About 69% of this 1989 harvest (2.048 million m^3) was in the form of pulpwood. The next highest proportion of the harvest was for industrial and domestic fuelwood (18%). In 1989, total fuelwood (softwood only) consumption was an estimated 530 000 m^3. Sawlog consumption accounted for another 346 000 m^3 or 12% of total softwood requirements. In 1987, an estimated 2100 sawmills were licensed in the province, of which 1400 operated. The remaining 55 000 m^3 were accounted for by export pulpwood and construction timber for wharfs and mining.

In Labrador, the total softwood consumption in 1989 was approximately 220 000 m^3 for export pulpwood to Europe and sawlogs for local markets.

Based on the 1989 estimates for AAC and wood consumption, the Island has a deficit of approximately 570 000 m^3, while Labrador has a surplus of 380 000 m^3. More specifically for the Island, the newsprint industry faces a deficit of approximately 213 000 m^3 based on supply from their own timber limits. The remaining 356 000 m^3 deficit is from unalienated Crown lands. The newsprint industry deficit may be less than anticipated due to recent reductions in fiber demand.

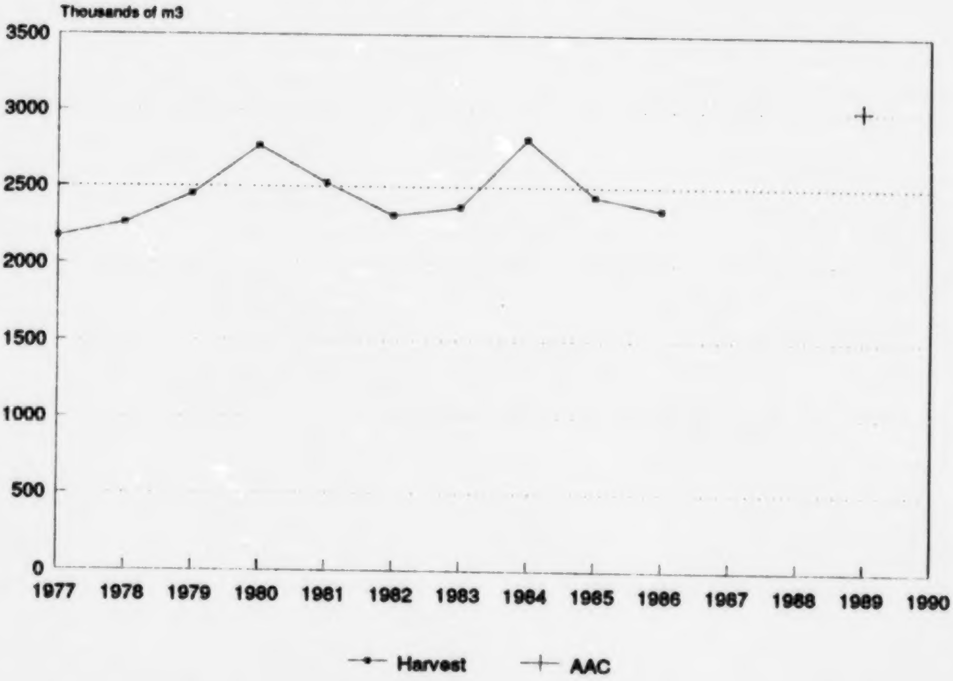

Figure A-36. Softwood timber harvest and AAC in Newfoundland.

One newsprint mill decided to close an older paper machine in 1990 thereby reducing wood requirements by approximately 160 000 m^3 per year.

The sawmill industry obtains most of its wood input from unalienated Crown lands. The deficit situation on these lands is reflected in a declining availability of high quality sawlogs. In some areas of the Island, the sawmill industry faces increasing competition for smaller logs from domestic fuelwood cutters.

7.10.4 Long-Term Timber Supply Outlook

The 1985 analysis of timber supply by the province indicated that even with expanded intensive silviculture, the estimated softwood AAC on the Island would decline substantially from approximately 3.0 million m^3 to about 2.3 million m^3 by the year 2020. The AAC was then forecast to recover slightly more than 2.5 million m^3 by the year 2025. These estimates were based on stand utilization levels of 60 m^3/ha and timber stands on slopes $\leq$ 30%. Estimates of AAC including stands from all slopes were more favorable but still indicated a forecast supply deficit.

The long-term AAC outlook from the 1989 Twenty-Year Plan was based on improved inventory data and more refined assumptions, particularly regarding land alienation and timber utilization. The results were not optimistic based on the harvesting of conventional roundwood using current technology. The supply/demand outlook to the year 2009 indicated a softwood deficit of approximately 590 000 m^3 taking into account the paper machine closure in one mill. The deficit occurs because of constant nondeclining harvests and expanded wood requirements. One of the major reasons for the forecast supply problem is the age-class structure of the forest.

The supply outlook beyond 20 years is more favorable, particulary with an assumption of increased silviculture. The model is very sensitive to changes in assumptions. By reducing operability limits, utilization losses, and land alienation, the model shows significant increases in the forest growing stock over one rotation.

The consensus among industry and government forestry officials is that the supply deficit will be a problem for another 2–3 decades. After this period, the effects of stand tending (both past and current) will alleviate the bulk of the supply constraint, especially for the newsprint industry. However, as described earlier, immediate increases in AAC can occur through better utilization of standing timber. Other options to expand supply during the deficit period include importing fiber from Labrador and utilizing the hardwood component in mixed stands for newsprint.

8. Glossary

accessibility. An assessment of the effect that availability of access, topography, and soil have upon the cost of harvesting a given timber stand.

Allowable Annual Cut (AAC). The volume of wood that may be harvested, under management, in a year.

allowable cut effect. The increase in early harvest from an existing forest that results from changed assumptions about the productivity of the future forest.

apparent surplus. The difference between the estimated AAC and harvest, if this difference is positive.

commercial species. A tree species for which there is a current market.

commercially operable. See **economically accessible**.

economically accessible. Forest management units and forest stands from which the AAC can be profitably harvested within the foreseeable future.

economically inaccessible. Forest management units and forest stands from which the AAC cannot be profitably harvested (at some specified date).

extensive margin. Defines the limit at which it is economically feasible (that is, profitable) to extract logs from the forest.

forest land. Land primarily intended for growing or currently supporting forest. Includes land not now forested, for example, clearcuts, northern lands that are now forested but not intended for use, and plantations.

forest management unit. An area of forest land managed as a unit for fiber production and other renewable resources. This unit can be the entire province or territory, a provincial forest management subdivision, an industrial timber limit, etc.

immature. In even-aged management, those trees or stands that have grown past the regeneration stage but are not yet mature.

industrial roundwood. Roundwood that is used to produce industrial forest products. Excludes fuelwood.

Long-Run Sustained Yield (LRSY). The level of harvest that is sustainable.

mature. In even-aged management, those trees or stands that are sufficiently developed to be harvestable and that are at or near rotation age (includes overmature trees and stands if an overmature class has not been recognized).

merchantable. Of a tree or stand that has attained sufficient size, quality, and/or volume to make it suitable for harvesting.

nonreserved (forest land). Forest land, that by law or by policy, is available for the harvesting of forest crops.

old growth. A stand of mature or overmature trees relatively uninfluenced by human activity.

overmature. In even-aged management, those trees or stands past the mature stage.

productive forest land. Forest land that is capable of producing a merchantable stand within a reasonable time.

regeneration. The renewal of a forest crop by natural or artificial means. Also, the new crop so obtained. The new crop is generally less than 1.3 m high.

regulated land Forest lands where the provincial government has control over setting or regulating the AAC.

roundwood. Sections of tree stems with or without bark. Includes logs, bolts, posts, pilings, and other products still "in the round."

stocked (forest land). Land supporting tree growth.

timber availability See **timber supply**.

timber supply — economic timber supply. The rate at which timber will be made available for harvesting in response to a range of product prices. Also sometimes refers to the economically accessible portion of the physical stock of timber.

timber supply — physical timber supply. The rate at which timber can be harvested (usually at a sustained level), without consideration of prices. Also sometimes refers to the physical stock or inventory of wood.

unregulated land. Forest lands where the provincial government has no control over setting or regulating the AAC. In most instances these are private lands.

withdrawals. Areas removed from the forest land base